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No. 2,400.] *FRIDAY, NOVEMBER 18, 1898.* *[Vol. XLVII.*

ONE-HUNDRED-AND-FORTY-FIFTH SESSION, 1898-9.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One-Hundred-and-Forty-Fifth Session was held on Wednesday evening, the 16th of November, when an Address was delivered by Sir John Wolfe Barry, K.C.B., M.Inst.C.E., F.R.S., Chairman of the Council.

The following arrangements have been made for the four meetings before Christmas :—

November 23.—Prof. George Forbes, F.R.S., "Long Distance Transmission of Electric Power." Sir John Wolfe Barry, K.C.B., M.Inst.C.E., F.R.S., Chairman of the Council, will preside.

„ 30.—C. H. Bothamley, F.C.S., "Photographic Developers and Development." Col. J. Waterhouse, Hon. Sec. Royal Photographic Society, will preside.

December 7.—W. T. Maud, "Egypt and the Soudan, in 1897 and 1898." Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., will preside.

„ 14.—Sir Albert Rollit, LL.D., M.P., "Commercial Education."

FOREIGN AND COLONIAL SECTION.

Tuesday, December 6, at 4.30 p.m.—Archibald Little, F.R.G.S., of Chungking, "The Yangtse Basin and the British Sphere." The Right Hon. Sir Richard Temple, Bart., G.C.S.I., C.I.E., will preside.

Papers for meetings after Christmas :—

PHILIP DAWSON, "Electric Traction and its Application to Railway Work."

L. F. VERNON-HARCOURT, M.A., "Canals and Inland Navigation in the United Kingdom."

S. B. BOULTON, "Preservation of Timber."

T. FORSTER BROWN, "Coal Supplies."

W. H. PREECE, C.B., F.R.S., "Wireless Telegraphy."

WILTON P. RIX, "Leadless Glazes."

W. HUNTING, "Tuberculosis in Animals."

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at 4.30 o'clock :—

January 19, February 9, March 9, April 13, May 11, 25.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday Afternoons, at 4.30 o'clock :—

December 6, February 28, March 21, April 25.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at 8 o'clock :—

January 31, February 21, March 14, April 18, May 2, 30.

CANTOR LECTURES.

Monday Evenings, at 8 o'clock :—

PROF. VIVIAN B. LEWES, "Acetylene." Four Lectures.

LECTURE I.—NOVEMBER 21.—The history of acetylene—Methods of formation—The chemistry of acetylene—The part played by acetylene in ordinary luminous flames.

LECTURE II.—NOVEMBER 28.—The commercial production of acetylene—Calcic carbide and its properties—The electric furnace and the various modifications in use for carbide manufacture—Carbide without electrical power—Carriage and storage of carbide.

LECTURE III.—DECEMBER 5.—The commercial generation of acetylene—The types of generator in use—The actions taking place in acetylene generators, and the effect upon the gas produced—The purification of acetylene for domestic consumption.

LECTURE IV.—DECEMBER 12.—The combustion of acetylene—Acetylene burners—Smoking and Carbonising of burners—Burners for heating—Acetylene for gas engines—Diluted acetylene and its applications.

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

January 16, 23, 30, February 6.

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

February 20, 27, March 6, 13.

PROF. HENRY R. PROCTER, "Leather Manufacture." Four Lectures.

April 10, 17, 24, May 1.

JUVENILE LECTURES.

Two Lectures, available for a Juvenile audience, will be delivered on Wednesday Evenings, January 4 and 11, at Seven o'clock.

CONVERSAZIONE.

The Annual Conversazione of the Society will be held on Wednesday, June 21. Each member receives a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, of Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department or science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session, three of which during the Session 1898-9 will be at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874 under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Four Meetings will be held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A Short Course of Lectures, suited for a Juvenile audience is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which Members are invited, each Member receiving a card for himself and a lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled :—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admission to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by Three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary.*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1898-99. It is issued subject to any necessary alterations:—

NOVEMBER, 1898.		
1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	**S**	
7	M	
8	Tu	
9	W	
10	Th	
11	F	
12	S	
13	**S**	
14	M	
15	Tu	
16	W	Opening Meeting
17	Th	
18	F	
19	S	
20	**S**	
21	M	Cantor Lecture I. 1
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	**S**	
28	M	Cantor Lecture I. 2
29	Tu	
30	W	Ordinary Meeting

DECEMBER, 1898.		
1	Th	
2	F	
3	S	
4	**S**	
5	M	Cantor Lecture I. 3
6	Tu	For. & Col. Section
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	**S**	
12	M	Cantor Lecture I. 4
13	Tu	
14	W	Ordinary Meeting
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	Christmas Day
26	M	*Bank Holiday*
27	Tu	
28	W	
29	Th	
30	F	
31	S	

JANUARY, 1899.		
1	**S**	
2	M	
3	Tu	
4	W	Juvenile Lecture I.
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	Juvenile Lecture II.
12	Th	
13	F	
14	S	
15	**S**	
16	M	Cantor Lecture II. 1
17	Tu	
18	W	Ordinary Meeting
19	Th	Indian Section
20	F	
21	S	
22	**S**	
23	M	Cantor Lecture II. 2
24	Tu	
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	**S**	
30	M	Cantor Lecture II. 3
31	Tu	Applied Art Section

FEBRUARY, 1899.		
1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	**S**	
6	M	Cantor Lecture II. 4
7	Tu	
8	W	Ordinary Meeting
9	Th	Indian Section
10	F	
11	S	
12	**S**	
13	M	
14	Tu	
15	W	Ordinary Meeting
16	Th	
17	F	
18	S	
19	**S**	
20	M	Cantor Lecture III. 1
21	Tu	Applied Art Section
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	**S**	
27	M	Cantor Lecture III. 2
28	Tu	For. & Col. Section

MARCH, 1899.		
1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	**S**	
6	M	Cantor Lecture III. 3
7	Tu	
8	W	Ordinary Meeting
9	Th	Indian Section
10	F	
11	S	
12	**S**	
13	M	Cantor Lecture III. 4
14	Tu	Applied Art Section
15	W	Ordinary Meeting
16	Th	
17	F	
18	S	
19	**S**	
20	M	
21	Tu	For. & Col. Section
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	**S**	
27	M	
28	Tu	
29	W	
30	Th	
31	F	Good Friday

APRIL, 1899.		
1	S	
2	**S**	Easter Sunday
3	M	*Bank Holiday*
4	Tu	
5	W	
6	Th	
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture IV. 1
11	Tu	
12	W	Ordinary Meeting
13	Th	Indian Section
14	F	
15	S	
16	**S**	
17	M	Cantor Lecture IV. 2
18	Tu	Applied Art Section
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	**S**	
24	M	Cantor Lecture IV. 3
25	Tu	For. & Col. Section
26	W	Ordinary Meeting
27	Th	
28	F	
29	S	
30	**S**	

MAY, 1899.		
1	M	Cantor Lecture IV. 4
2	Tu	Applied Art Section
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	**S**	
8	M	
9	Tu	
10	W	Ordinary Meeting
11	Th	Indian Section
12	F	
13	S	
14	**S**	
15	M	
16	Tu	
17	W	Ordinary Meeting
18	Th	
19	F	
20	S	
21	**S**	Whit Sunday
22	M	*Bank Holiday*
23	Tu	
24	W	Ordinary Meeting
25	Th	Indian Section
26	F	
27	S	
28	**S**	
29	M	
30	Tu	Applied Art Section
31	W	Ordinary Meeting

JUNE, 1899.		
1	Th	
2	F	
3	S	
4	**S**	
5	M	
6	Tu	
7	W	
8	Th	
9	F	
10	S	
11	**S**	
12	M	
13	Tu	
14	W	
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	
21	W	Conversazione
22	Th	
23	F	
24	S	
25	**S**	
26	M	
27	Tu	
28	W	Annual General Meeting
29	Th	
30	F	

The Chair will be taken at Eight o'clock at each of the Ordinary Meetings, the Cantor Lectures, and the Meetings of the Applied Art Section.

The Meetings of the Indian Section and the Foreign and Colonial Section will commence at either Half-past Four or Eight o'clock, as may be announced from time to time.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Seven o'clock.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 16, 1898; SIR JOHN WOLFE BARRY, K.C.B., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Acland, Sir C. Thomas Dyke, Bart., Killerton, Devon.
Annear, Joseph Henry, Morwell-cottage, West-street, Harwich.
Bannerman, William Bruce, The Lindens, Sydenham-road, Croydon.
Bhumgara, Jamsetjee S., 135, London-wall, E.C., and 8, Loudoun-road, N.W.
Boult, Wilfrid Swanwick, Sudbury, Beechcroft-road, Upper Tooting, S.W.
Boyd, William Christopher, The Grange, Waltham-cross, Herts.
Brickwood, John, Ortageny, Southsea, Hants.
Brown, Alfred Charles, Eastern Telegraph Company, Winchester-house, Old Broad-street, E.C., and 129, Algernon-road, Lewisham, S.E.
Burrell, Arthur William, M.D., 5, Baker-street, W.
Byrne, Rev. Father, Catholic Presbytery, Court-road, Barry Dock, Glamorganshire.
Carey, Alfred Edward, 39, Trinity-square, Tower-hill, E.C.
Cawson, James, 8, Alfred-place, Bedford-square, W.C.
Cheesley, Robert Godwin, Westrop-villas, 16, Canonbury-street, N.
Corner, Walter William, 115, Fellows-road, South Hampstead, N.W., and City Liberal Club, Walbrook, E.C.
Coventry, Henry G., Worsley, near Manchester.
Coventry, Walter Bulkeley, Burgate-house, Fordingbridge, Salisbury.
DeBrath, Stanley, Grande Roque, Guernsey.
Dodds, John Bradburne, Stotes hall, Jesmond, Newcastle-on-Tyne.
Duncan, Harold M., Hyde-park-court, Albert-gate, S.W.
Duncanson, Edward Ford, Nutwood, Bickley, Kent.
Edgcumbe, Kenelm, 33, Tedworth-square, S.W.
Elworthy, Thomas, London-road, St. Leonard's-on-Sea.
Erskine, Captain William Charles Chitty, New Club, Princes-street, Edinburgh.
Finny, Commander T. G. R., R.I.M., Royal Bombay Yacht Club-chambers, Bombay.
Gadsby, Charles Herbert, Donington-house, Norfolk-street, Strand, W.C.
Gibb, Alexander, 23, Chapter-road, Willesden-green, N.W.
Gibson, William Augustus, 4, Queen Victoria-street, E.C.
Girtin, George Wyndham Hog, 125A, Highbury New-park, N.
Gordon, William Gordon, Knowlesly, Port of Spain Trinidad.
Gould, Henry, 1, Matthew's-lane, Kingston, Jamaica.
Hamong, Count de, 180, New Bond-street, W.
Harding, Josiah, 51, Hill-lane, Southampton.
Hay, Walter Robert, 20, Abchurch-lane, E.C.
Holah, Ernest, 5, Crown-court, Cheapside, E.C., and Sun Trap, Radcliffe-road, Croydon.
Howard, Henry Lionel, 38, St. George's-road, S.W.
Humphreys, Henry Howard, 6, Stanley-gardens, Willesden-green, N.W.
Jones, Walter Lindley, 21, St. Helen's-place, E.C.
Kimmins, C. W., M.A., D.Sc., Bermondsey Settlement-lodge, Farncombe-street, S.E.
Langdon, William, Oakfields, Kingsbury, N.W.
Lugard, Cecil Edward, 97, Sinclair-road, West Kensington, W.
Mackenzie, Sir Alexander, K.C.S.I., 71, Lancaster-gate, W.
Mair, George John, Millom, Cumberland.
Marshall, Charles H., The Poplars, Howard-street, York.
May, Cornelius, Oxford-street, Freetown, Sierra Leone.
O'Dwyer, Arthur Williamson, Duketown, Old Calabar, Niger Coast Protectorate, West Africa.
Ormerod, John, 62, Chorley New-road, Bolton.
Osman, Constant Edward, 132, Commercial-street, E.
Oulton, William, J.P. (Lord Mayor of Liverpool), Hillside, Gateacre, Liverpool.
Park, C. J., 23, Mutley-plain, Plymouth.
Parkinson, John, 251, Camden-road, N.
Pentheny-O'Kelly, Captain Edmund de, Sierra Leone, West Africa, and Badminton Club, 100, Piccadilly, W.
Pickering, Robert Young, Railway Wagon Works, Wishaw, N.B.
Plant, Edmund H. T., Charters Towers, North Queensland.
Reed, Frederick Richard Cowper, M.A., The Limes, Oxford-road, Cambridge.
Rollin, Charles, B.Sc., 1, Queen's-road, Jesmond, Newcastle-on-Tyne.
Ross, Alexander, Great Northern Railway, King's-cross Station, N.
Rundell, T. W., 25, Castle-street, Liverpool.
Sam, Thomas Birch Freeman, Cape Coast Castle, West Africa.
Sayer, Henry, 10, Nottingham-terrace, N.W.
Schattner, Ernest B., 78, Mill Hill-road, Norwich.
Scott, Sir John, K.C.M.G., M.A., Malabar-house, St. Albans, and 1, Adam-street, Adelphi, W.C.
Sheer, John, 13, King's College-road, South Hampstead, N.W.
Skilbeck, George Thornton, Clonard, Harrow Weald, Middlesex.
Stevens, Charles Cecil, C.S.I., Fair View, Church-hill, Honiton.
Swan, Edward Arthur, 74, Culverden-park-road, Tunbridge Wells.

Vaughan, J. C., Wraxall, near Bristol.
Walker, Thomas Speck, J.P., Stafford-villa, Thornaby-on-Tees.
Ware, Captain F. Webb, I.C.S., Quetta, Baluchistan, India.
Wilson, Norman James, 70 Waterloo-road, N., Wolverhampton.
Woollan, Benjamin Minors, Fairfield-lodge, 6, Addison-road, W.

The CHAIRMAN delivered the following

ADDRESS.

I have to express my thanks to the Council for the honour which they have done me in electing me to the Chair of this important Society, and to bespeak the forbearance of its members in repect of any shortcomings on my part in the fulfilment of the duties of the post. In following so many distinguished men who have been Chairmen of the Council, and in the contemplation of the multifarious labours which attach to the position, I cannot but feel much misgiving as to my ability to adequately fill the position. But having served for some time on the Council, I know the loyal support which it has always accorded to its Chairman, and I am aware also of the assistance which the experience and devotion of the Secretary and staff have uniformly extended to the Chairman and Council. I feel certain that I may rely on these advantages myself, and in that confidence I will only say that I will do my utmost to uphold with the help of the Council, the great interests which the Society of Arts represents.

In selecting a subject for my opening address, I have thought that there is one which touches all our interests, and with which I happen to have been brought in connection for many years. It will oblige me to allude to some of the many aspects of modern London, as the particular question which I propose to consider is that of the means of communication of its inhabitants with each other by means of its streets and thoroughfares. I take this to be one of the pressing matters of the present time, not only in respect of the existing state of things, but still more in view of the future requirements of our ever growing population.

If I can succeed in bringing before you sufficient information and such a view of the questions involved as to induce some systematic consideration of this great subject, I shall feel that my labour has not been thrown away. I feel sure that nowhere will the subject find more adequate recognition than in this theatre, in which so many problems for the amelioration of our physical conditions have been discussed and forwarded.

Before we approach the detailed consideration of my topic we must realise its extent and boundaries, and the first question which arises is — What is to be understood as London? and in particular what is the London which we have in our mind when we speak of its streets.

If we take London as defined by the jurisdiction of the Metropolitan and City Police, we have an area of 688 square miles, and a population of nearly 6,000,000. If we deal with Postal London we have an area of 243 square miles, and a population of perhaps from five to five-and-a-quarter millions. And if we reckon as London, the County of London and City of London controlled for municipal purposes by the London County Council and the Corporation, we are dealing with an area of 115 square miles, and a population of upwards of 4,500,000.

In the consideration for our purposes of the County of London there should be added the southern portion of West Ham, which district is not included in it for administrative purposes, and we thus arrive at an area nearly oval in shape, having a major axis, east and west, of 12 miles, and a minor axis, north and south, of 11 miles. This area would contain about 122 square miles, and a population of nearly 5,000,000. It is the region as last defined which we may denominate as London with its environs as distinguished from Greater London, under which term I include the much larger area within the police boundaries.

Once more we must recognise that London and its environs, with its 5,000,000 of inhabitants, may be roughly divided into urban and suburban portions, and without attempting a precise division I think that we may take it that the parts continuously built upon and covered with streets and houses as distinguished from roads and lanes, villas and cottages, have an area of about 95 square miles and a population of perhaps 4,000,000. This area we may distinguish as Urban London.

The last-mentioned estimate can only be a rough approximation, for everywhere things are in a state of transition, and roads and villas are continually giving place to continuous streets and houses.

We talk glibly of millions, but it is difficult for the human mind to realise what a million means. Perhaps the following illustration may help us. A person counting aloud can in a minute count from 140 to 180, depending

on his power of enunciation. If we adopt an average of 150 per minute, and I assume that he will not repeat the complicated numbers, but will count up to 100 and then a second 100 and so on, 7,000 minutes will be required in which to count one million. Seven thousand minutes amount approximately to 10 days of 12 hours each. Thus, if a man could perform such a feat of endurance, and could count as rapidly as 150 per minute, he would be occupied for twelve hours a day, from the 1st of December to the 29th of January, in counting the present population of Greater London.

So far as the effects of population are concerned, it is necessary to take careful note of the 6,000,000 of Greater London as well as of the inhabitants of the more immediate suburbs of London, because the question of intercommunication in Urban London is intimately bound up with matters which are brought into prominence by the existence and growth of the whole area. It may confidently be said that the inhabitants of the whole of the 688 square miles, and those from a still larger area, are more or less constantly passing in and out of the strictly urban portions, thronging the streets with pedestrian and wheeled traffic of all descriptions. An active circulation is kept up, as in the human body, from all parts to and from the central heart of the system. We must keep this fact prominently before us in the consideration of the streets and thoroughfares of Urban London.

Some years ago (in 1891) the daily influx and efflux of traffic as to and from the City only was enumerated and found to amount to a total of 1,186,000 individuals. To these must be added the ebb and flow of traffic in other business centres, such as Westminster, the Strand, Oxford-street, the Temple, and its neighbourhood; but, as far as I know, no systematic counting has ever been made except in the City itself.

Again, in the middle of the day there are the numberless ladies and others who come for their shopping or visits to the western and central parts of the town, and we have also in the evenings the theatre-going and amusement-seeking public. Both these classes come from the suburbs and return there in great and increasing numbers.

In this connection we may note the great augmentation in the number of theatres and other places of amusement within the last thirty or forty years. These, though chiefly situated in the most central parts of London, undoubtedly rely greatly, if not mainly, on the patronage of those who live in the suburbs or of those who are staying in town as visitors from remoter parts. The same may be said of the great retail shops, warehouses, and stores. Both have increased greatly in neighbourhoods in which the resident population is either stationary in numbers or diminishing, indicating clearly enough that the choice of position is independent of the number of neighbouring inhabitants.

To a large extent this great circulation of traffic in and out of Central London is the creation of the last thirty or forty years, and it has added enormously to the demands on our street accommodation, as compared with the requirements of that volume of traffic which existed when the streets were mainly used by those who dwelt within perhaps two or three miles of Charing-cross; and when it was said the "Tide of Life is seen at Charing Cross."

Forty years will take us back to a date anterior to the opening of the Metropolitan and District Railways; and it will be interesting to note in a general way what has been done by railway companies in the endeavour to keep pace with the growth of suburban traffic within, for example, 20 miles of London. Afterwards we may profitably consider what has been undertaken during the same period by municipal bodies towards improving the streets.

Forty years ago none of our main lines had more than two tracks of rails into London—now all have at least four; and it is common knowledge that the necessity for widening our railways into London has been mainly occasioned by the rapid and continuous growth of suburban traffic. The Charing-cross line, with Cannon-street Station, was but thought of. Victoria, Broad-street, Liverpool-street, Fenchurch-street stations, all of which are chiefly occupied by suburban traffic, either did not exist or had been too recently opened to have produced their full effect, and the Midland Railway had not reached London.

The Joint Committee of Parliament which sat in 1864 on the various schemes which were then promoted in order to endeavour to grapple with the ebb and flow of traffic and its distribution, had very much in view the crowded state of the streets, and the hope was general that a circular railway touching the chief terminal stations of the main lines together with a line under the Thames through the old Thames Tunnel, and another line of underground railways from north to south through the centre of London, would effectually relieve the traffic of the streets.

The lines thus recommended by the Joint Committee resulted in the Inner Circle line, with extensions east and west and junctions with most of the main lines; in the East London Railway, utilising the Thames Tunnel for access to South London; and in the St. John's-wood line, giving access to its northern suburbs. In addition to these the northern and southern districts have been connected by the West London Railway and by the junction at Ludgate-hill between the Chatham and Dover and Metropolitan Railways and the Midland; the Great Western, the Great Northern, and the North-Western systems have been brought into the heart of the City. Another useful line recommended, but not yet made, would have joined the South-Eastern and North-Western Companies' systems by a route from Charing-cross-bridge to Camden-town.

We have lately seen the construction of the City and South London and of the Waterloo and City Railways, and the highly-important Central London Railway from Shepherd's-bush to the heart of the City is rapidly approaching completion.

I roughly estimate that in the widenings of the railways above mentioned and in the various metropolitan and suburban lines constructed since 1858, an expenditure has been made or incurred of not less than £60,000,000 sterling, of which more than half has been incurred during the past 20 years.

The result, so far as the public streets are concerned, has certainly not answered the expectations which were formed by Parliament. Not only have the Metropolitan and District Railways, as well as the other railways alluded to, developed an enormous additional suburban traffic of their own, which has been thrown into inner London, but the facilities afforded by the various metropolitan lines have increased the amount of travelling from one part to another of the central parts of London itself, thus adding greatly to the movement of those inhabiting the town itself, and using the public thoroughfares.

I have tried to estimate the daily number of persons entering and leaving urban London daily by railways only, from and to the suburbs, and I arrive at the large number of 960,000. This amount of traffic, which is to a great extent new since 1858, is all thrown on the streets either in the form of pedestrian or omnibus or cab traffic to and from the railway stations and the destination of the travellers.

After the railways, consider the increase of omnibus traffic. In 1871 there were 1,268 of those vehicles which the police call "metropolitan stage carriages" and the ordinary man knows as omnibuses, and now there are 3,170, and 1,000 tramcars. Thus the number of these vehicles has more than trebled.

If a man stands in Cheapside, he will in an hour count 384 omnibuses as passing him; if in the Strand, 444; if in Piccadilly, 423; if in Tottenham-court-road, 487, or an average of from 6 to 8 omnibuses in every minute.

As to cabs (which the police equally mysteriously denominate "hackney carriages"), in 1871 there were 7,341, and now there are no less than 11,034, and this great increase has occurred in spite of the establishment of late years of railway omnibuses.

Another means of transit remains to be alluded to, namely, the river steamboats. This subject introduces some interesting considerations. When I was a boy the steamboat service was better and much more used than at present. There were two independent lines of steamers, one of which ran only between Westminster to the City, while the other started from Chelsea or higher up the river and ended the journey at London-bridge; some were express steamers stopping once on the journey, and others at every pier. I think a steamer was available every five minutes from one end or the other of Westminster-bridge, and they travelled at a good speed. In addition, the means of access by steamboat were very good from Putney on the west, and from Woolwich on the east, to London-bridge.

These facilities have largely disappeared, and though several efforts have been made to improve the service and attract traffic, they have not been very successful. I think the reason is to be found in those facts of suburban dispersion to which I have alluded, added to the comparatively low rate of average speed on a river with a strong tide, as compared with the speed even of metropolitan railways, and to some extent in the character of accommodation on the London steamers; still more in the inconvenient situation of the City piers; and lastly in the competition of the quicker mode of transport by railways.

Though steamboat travelling might easily be made more attractive, I question whether there is much scope for further development in it, and certainly not to the extent of its being of great value in grappling with the continued demand for circulation in urban London. Nevertheless there are very considerable numbers of

persons still conveyed by the river steamers. The Thames Steamboat Company have 35 steamers running during the summer, and none during the winter months.

As to cart and waggon traffic, the numbers are continually growing. In 1858 there were but few railway vans—now there are 6,000, and the increase in the number of other carts, postal vehicles, and waggons can only be marked as most considerable without the possibility of actual enumeration. The traffic of carts and waggons bringing produce into London, especially from the market gardens, and returning with manure or empty, is almost continuous, and scarcely ceases for more than an hour or two during each 24 hours. As London grows in numbers, there is more and more pressure on the central districts in which are situated the markets and places of distribution for the whole of the urban and most of the suburban retail trade.

Lastly, we have the bicycles, at present in their stage of infancy or early growth, the numbers of which are only kept down in the metropolis by the dangers which their riders encounter in our streets. This mode of travelling, which will yearly grow in importance and that very rapidly throughout the whole civilised world, is one upon which I shall have more to say later on. It is a mode of conveyance which should not be undervalued or lost sight of, but which is, practically speaking, impossible at present in Urban London.

To sum up, in the endeavour to give some idea of the results of these various modes of discharging traffic upon the streets, I have had observations taken, and find that the total numbers of vehicles and foot-passengers passing the spots, alluded to above, in a busy hour, are as follows :—

	Vehicles.	Pedestrians.
Cheapside	992	6,358
The Strand	1,228	5,660
Piccadilly	1,497	3,910
Tottenham-court-road	661	5,586

The great traffic which I have endeavoured to describe is most wonderfully controlled by the police, but no one who has lived in London can doubt that the pressure on the streets is getting yearly heavier and heavier, and becoming more and more unmanageable. I think, that it must continue to increase for reasons apart from the mere increase of population, and to these causes I will presently allude.

The increase of population is, of course, a most important consideration, and I do not at all wish to lose sight of it, and the following figures indicate some remarkable results:—

In 1851 the population of what is now the County of London was 2,330,000, and it is now 4,500,000, but in the consideration of this increase as a whole, it is a noteworthy fact that in many of the the central districts of London, not only has there been no increase of resident population, but, on the contrary, a serious diminution of numbers.

For example, as between 1851 and 1896, we note the following decreases :—

In the City	127,000	to	31,000
,, Holborn	47,000	,,	31,000
,, Marylebone	158,000	,,	141,000
,, St. Giles	54,000	,,	38,000
,, St. James	36,000	,,	23,000
,, St. Martin	25,000	,,	13,000
,, Strand	44,000	,,	24,000
,, Westminster	65,000	,,	53,000

Being a decrease in these districts alone of 202,000, or 36 per cent.

Others of the central districts are nearly stationary in numbers, and it may be safely said, that the great growth in the numbers of residents is almost entirely in the immediate suburbs of the Urban London of 1851.

Contrasted with these figures the increase of population between 1851 and 1896, in the undermentioned districts, not to mention others has been as follows :—

Battersea	from	11,000	to	165,000
Camberwell	,,	55,000	,,	253,000
Fulham	,,	12,000	,,	114,000
Greenwich	,,	67,000	,,	176,000
Hackney	,,	54,000	,,	213,000
Hammersmith	,,	18,000	,,	104,000
Hampstead	,,	12,000	,,	75,000
Islington	,,	95,000	,,	337,000
Kensington	,,	44,000	,,	170,000
Lambeth	,,	139,000	,,	295,000
Lewisham	,,	16,000	,,	104,000
West Ham	,,	19,000	,,	270,000

Being an increase in the districts mentioned of 1,734,000, or over 300 per cent.

These are all districts within the outskirts of what I have called Urban London. If we extend our view to the suburbs of Greater London, such as Bromley, Enfield, Harrow, Willesden, Ealing, Staines, Richmond, Twickenham, Kingston, and Croydon, it

appears that the increase between 1851 and 1896 is no less than 3,200,000, or 125 per cent.

The ratio in the decennial growth of population in London, including its suburbs, shows some slight sign of diminution by the last census, it is still sufficiently startling to find that during the past decade the average increase is nearly 100,000 per annum, equivalent to the population of a town like Huddersfield being added yearly to the numbers of the metropolis.

The late Royal Commission on the Water Supply of London tells us what we are to expect in the future. After careful study of the question they came to the conclusion that in 1931 Greater London would contain a minimum population of $8\frac{1}{2}$ millions with a maximum of nearly 12 millions, depending on the present and former ratios of annual increase.

As I have said, the striking feature of the condition of modern London is the continual stream of traffic between the extremities and the central parts. Now I take it that the rapid increase in the population of the suburbs, as compared with the strictly urban parts of the metropolis, is due to three prominent causes.

First, the increased wealth of the middle and labouring classes.

Second, the modern development of cheap transport.

Third, the extreme value of the sites in Central London, and the desire of all for more accommodation in their houses and their surroundings.

(1.) With regard to the first and second of these causes, we find that the rateable value of the County of London (excluding the City) per inhabitant in 1871 was £5 9s. 2d, and is now £7 2s. 4d. Apart from this test, we know that wages and salaries have increased in a larger proportion. The augmentation of wages of artisans and labourers cannot be less than 35 per cent. in the last 30 years, while, with the exception of house-rent, all the necessities and luxuries of life are conspicuously cheaper. Thus there is a much larger margin for that travelling which not only enables many to live at a considerable distance from their work, but permits them to move in and out of London in connection with entertainments and pleasures of various kinds.

(2.) I have already indicated what railway companies have done in providing physical means of access to the suburbs, by widenings of their lines and by extensions of their systems. These improvements have resulted in cheap fares, season tickets, and workmen's tickets at prices unknown in former times. Thus a third-class season ticket for a year will enable a man to perform 600 journeys for a distance of, say, 12 miles for 3·8d. per journey; while workmen's tickets enable their holders to come to and from, say, Enfield, a distance of 22 miles at 2d. per journey. Omnibus fares again, since 1851, have been reduced by about 50 per cent., and the introduction of the penny fare has immensely increased the short distance journeys. Again, as tramways have been introduced within the same period, the fares paid, in proportion to distances, have been still further diminished within the period under review.

If, as has been the case in Glasgow, halfpenny fares by tramcars and omnibuses are introduced, we shall doubtless see an enormous increase in the number of these vehicles and a greater crowding of our streets than can be easily realised.

Apart from suburban developments, it is to be observed with regard to railways in connection with the country at large, that the great concession to third-class travellers inaugurated by the Midland Railway, by the enlightened advice of the late Sir James Allport, under which third-class carriages are attached to all trains, has caused an immense and even startling increase of travelling throughout the whole country, and naturally the metropolis has experienced a very large amount of that increase, as it attracts visitors to itself in far larger numbers than formerly was possible, from all parts of the kingdom far outside the limit of Greater London.

(3.) The other cause of suburban development which I mentioned, viz., the rise in value of land in central situations since 1851, is most remarkable. It is one of the great difficulties which the London County Council have found in dealing with the important matter of housing the working-classes, of which problem the gravity and magnitude are frankly recognised by the Council.

The Chairman of the County Council recently stated that, in the case of the proposed street from Holborn to the Strand, the value of sites in the immediate neighbourhood of the improvement was so high that the use of the land for housing the working-classes, who would be dispossessed, would mean a loss to the Council of £260 per person apart from the value of the buildings to be constructed for the purpose, whereas on a site only $1\frac{1}{2}$ miles distance the cost for land would be but £9 per head. Of course, still further afield it would be still more reduced.

These facts, which are more or less applic

able in other schemes for accommodating the working-classes in central stations, are potent reasons, apart from all other considerations, why easy, speedy, and cheap locomotion are vital questions for the welfare of London, and why the volume of traffic in our streets indicates continuous increase, keeping pace with and in many places overtaking the means of accommodating it.

These appear to me to be some salient points of the necessities of the case, which produce the congestion of our streets, and tend to rapidly add to that congestion. I have to some extent described, however briefly, some of the means to meet them which have been provided by private enterprise, such as by railway, omnibus, tramway, and steamboat companies, and commercial enterprise in general, as distinguished from Government and municipal efforts.

I leave aside such questions as the acquisition of tramway lines by the County Council, which only very indirectly touch the subject, being a mere change of ownership and management, possibly though not certainly resulting in cheaper fares.

I propose now to consider the new streets and widenings of streets which have been effected in the last 50 years with a view of facilitating the constantly growing streams of traffic.

In comparison with the large expenditure by railway and tramway companies we cannot but be struck with the smallness of the mileage of streets made and of the capital expended.

The following are the most prominent of the street improvements executed within the last 40 years, exclusive of the Thames-embankments :—

Date.		Length. Furlongs.	Cost. £
1854.	Cannon-street	$3\frac{1}{2}$	500,000
1864.	Southwark-street	5	366,000
1870.	Holborn-viaduct and streets connected with it	6	2,552,000
1871.	Hamilton-place	1	111,000
1871.	Queen Victoria-street	5	1,076,000
1876.	Northumbertand-avenue	$1\frac{1}{2}$	711,000
1882.	Tooley-street	6	405,000
1883.	Hyde-park-corner	1	11,000
1884.	Eastcheap	$1\frac{1}{4}$	600,000
1886.	Shaftesbury-avenue	5	779,000
1887.	Charing Cross-road	4	584,000
	Totals	4 m. $7\frac{1}{4}$ f.	£7,695,000

This total amount, small as it is for the metropolis during nearly 40 years, is really an over-statement, as it takes no account of the recoupment by sale of surplus property, improved rents, or the like. On the other hand, there are no doubt many street improvements which I have not noticed which are of less prominence. But in the aggregate, and when all are recognised, the amount of expenditure in so long a period cannot but appear very small.

In the matter of street improvements in London also, one cannot but notice an almost entire absence of grasp of a large subject. We can, no doubt, record some useful and even fine undertakings, but in the history of the past 40 years, we look in vain for any new arterial thoroughfares traversing Inner London from end to end, and proportioned in width to the demands upon them at different parts of their route. On the contrary, we find in the new streets, as in the old ones, that the nearer they are to the heaviest of the traffic, the narrower they are in absolute dimensions.

Cheapside, Fleet-street, Piccadilly, the Strand, Oxford-street, Marylebone and Euston-roads remain very much as they were 50 years ago, when the traffic was a mere fraction of what it is now, and there has been, practically speaking, no attempt at improvement in these most important thoroughfares. In the case of the Strand, no doubt some relief has been found from the Thames-embankment, promoted, though it was only in a minor degree, as a thoroughfare, but the monstrous condition of the Strand at crowded hours of the day and night shows that the embankment roadway, which has been opened 28 years, has failed altogether to afford the necessary relief. At such times, one can say, in the words of Hood, that there is

"No road, no street, no t'other side the way."

I desire to speak with all respect of those who years ago conceived and executed the idea of Regent-street. I believe we have to thank Nash the architect and the Prince Regent for having made an improvement in the arterial line from north to south in a large-minded way and with some conception of the requirements of that time, and of provision for the future.

If we can imagine that in 1813, when Regent-street was designed, the four east and west routes by Pall-mall, Piccadilly, Oxford-street, and the New road were adequate for the east and west traffic, we can see that Nash's wide Waterloo-place and Regent-street with its circuses at Piccadilly and Oxford-street,

and joining the only 100 feet street in Mid-London, Portland-place, except Whitehall which is 125 feet wide, was a work conceived in a large-minded way, and was a real effort to deal with the requirements of the traffic north and south at the western end of London.

When, however, we come to consider more modern street improvements, most of them at least seem piecemeal and patchwork enterprises narrowed to the very least dimensions which would pass muster, and without any but the most meagre provision for the future, or, except in the case of Regent-street, the slightest attempt at systematic artistic treatment of the question. In fact there has been and is now a hitherto incurable *petitesse* in dealing with such matters in London, which is a great contrast to what we see in foreign cities of far less importance and of far less wealth than those of the English metropolis.

For example, when Queen Victoria-street was made—a highly useful and costly undertaking—not only was the inadequate width of 65 feet adopted for a street with shops and warehouses on both sides, which is in prolongation of the 110 feet of the Victoria-embankment, which has no buildings upon it at which vehicles stop to load and unload, but where Queen Victoria-street crosses Cannon-street, a street (New Earl-street) made in former years, which had only a width of 50 feet, was allowed to remain and form part of the new Queen Victoria-street.

Again, where the new street was to reach the Mansion House no provision was made by any widening of existing thoroughfares to carry forward the traffic, and as Queen Victoria-street in the nature of things was only a means to an end, viz., for traffic to reach the heart of the city, the congestion at the Mansion House could not be relieved by it, and we daily see this highly expensive street blocked by traffic at Cannon-street and at the Poultry, and the confusion at the Mansion House worse confounded.

In the instance too, of the important widenings of Eastcheap and Tower-street, made—only some 15 years ago—at the joint expense of the Metropolitan Board of Works, the City, and the Metropolitan and District Railway Companies, a width of only 60 feet was adopted, though I remember the late Colonel Haywood, the experienced engineer of the Commissioners of Sewers stating that even 80 feet would soon be found inadequate. His prophecy has been already fulfilled. The widening of Ludgate-hill, but very recently completed, only leaves this most important approach 59 feet wide, crowded with shops on both sides, and Fleet-street remains untouched with a width of 45 feet.

The highly useful and well-designed Holborn Viaduct improvement was a local and not an arterial improvement, for it left Newgate-street and Cheapside unaltered, and was the means of facilitating the bringing of traffic to another point of congestion.

In more modern improvements the width of 60 feet has been adopted for Shaftesbury-avenue, and the Charing-cross-road, and one can even now easily see that in a few years they will be found much too narrow, though the north and south traffic does not probably call for such widths as does that from west to east.

Even in the case of Northumberland-avenue one cannot but notice the same fatal parsimony. If ever there was a case for a fine street, as approaching the Thames-embankment, this surely was one, and at the time at which it was made, urgent remonstrances were made in favour of a width of 100 feet. But it was in vain, some not very important banking house would have been required, and to save this the line of the avenue was altered, and a width of 80 feet adopted as an approach to the embankment roadway which is 110 feet wide.

Now of course it must be admitted that a street 80 feet or 100 feet wide will cost more than one 60 feet wide, but it will not cost proportionally more, and this is specially the case when a street is widened and not cut transversely to existing streets.

If one assumes a street of 60 feet from house to house, about 12 feet on each side must be devoted to footways, leaving 36 feet for vehicular traffic. One must deduct about 9 feet on each side for drays and carts standing at the houses, and all that remains is 18 feet, which is only adequate to two or at most three lines of moving vehicles.

But when one criticises these dimensions, what is to be said of the Strand (50 feet wide constricted at one of the busiest parts to 40 feet) and Piccadilly from Sackville-street to Regent-street (55 feet wide), or Cheapside (50 feet wide), except that they are ludicrously inadequate to the demands of a great city flooded daily with an enormous influx from a closely populated area of 688 square miles.

What do we find in continental cities? In Paris, the old Boulevards have a width of 100 feet or over, the Rue de Rivoli (made 60 years ago) of 80 feet, the new Boulevards, a

width of 80 to 130 feet. In Vienna, the Ringstrasse has a width of 175 feet, in Buda-Pesth the Andrassy Strasse must be 140 feet wide, and in New York the principal Avenues have widths of 80 to 150 feet.

If we take Paris alone by way of contrast with our metropolis, we find that in about 40 years the following important street improvements have been effected, besides many others :—

Completion of	Length. (miles.)	Width. (feet.)
Rue de Rivoli	1·4	80
Boulevard Sebastopol	2·5	95
,, Strasbourg	2·5	95
,, Haussman	1·7	95
,, Malesherbes	1·7	125
,, du Palais	0·2	130
,, St. Michel	1·1	80
,, St. Germain	2·0	125
,, Magenta	1·2	90
,, Voltaire	2·0	95
Avenue de l'Opera	0·5	95
Rue de quatre Septembre	0·6	80
Avenues leading to the Champs Elysées	3·5	100
Total..	18·4	miles.

As in my reference to the principal street improvements of London, so in the case of Paris, there must be a large number of less prominent works the aggregate of which must be very considerable, and more in proportion than the London improvements not included in my list.

It is to be carefully borne in mind that the want of accommodation for the traffic in the streets of London is not merely a question of grumbling of those who suffer from it, but involves many other considerations. In the first place there is daily and hourly loss of much money in the delays to men of business or in professions, and to the operative classes. We must add loss of time to vehicles and horses, the practical impossibility of introducing cheaper and more expeditious means of transit, such as by electric tramways, and great want of free circulation of air.

I may here refer to the extremely valuable and interesting report on City improvements, written by Colonel Haywood to the City Commissioners of Sewers as long ago as 1867, in which he points out the immense loss of money daily occasioned by inadequate streets, and recommends various modes of relieving the recognised congestion of the City. Some of these recommendations, such as the Holborn-viaduct and the Tower-bridge, have been carried out; but we look in vain for the great arterial street, recommended in the same report, extending from Newgate, on the west, to the Commercial-road, on the east.

As to one aspect of the financial returns of improved streets and gradients, I find in Colonel Haywood's report that, about 1847, it was stated before a Parliamentary Committee that the annual loss incurred in carriage traffic alone on Holborn and Ludgate hills amounted to £100,000. And again, on the same subject, he remarks :—

"Thus, inadequate thoroughfares are not only inconvenient but are expensive to the public; lead to police regulations which impede the free and natural course of the traffic and business of a community; and are repugnant to the spirit of the age. Evidence may, at the present time, be adduced in support of these views, by reference to the Traffic Bill now [1867] before the Houses of Parliament. By it the hours during which coals can be delivered are to be much restricted, and it is computed by one who has unusual opportunities of forming a sound opinion on the subject, that it will result in the price of coals being increased to the consnmer as much as 2s. 6d. per ton, involving a total loss to the metropolitan inhabitants of between £400,000 and £500,000 annually."

I mention such figures not as any attempt to estimate the whole effect, but as illustrations of the great influence on the trade generally in a great city of adequate or inadequate thoroughfares.

In the consideration again of wide and narrow streets, we can recognise that, apart from the circulation of air, the ground on each side cannot be so well utilised by lofty buildings in the narrower thoroughfare. It is rightly a regulation in London that an angle of 45° at the pavement should be subtended by the opposite side of a new street. Thus a street 60 feet wide will permit of 40 feet less in height on each side of a street being devoted to additional stories as compared with a street 100 feet wide. Consequently, three stories on each side of the street are lost by the narrower street. In these days of rapidly moving lifts, which give value to the upper stories, such a consideration ought to be at least a great help towards the extra cost of the land required for the wider street.

Again, one broad continuous thoroughfare is, so far as the circulation of air is concerned, a vastly different thing to the same width cut up into two narrow streets, and would tend to improved health and sanitation.

Apart from time saved and the benefits to health the question of accidents to life and limb, which might be avoided by less crowding of vehicular traffic, should not be lost sight of. At present no less than 150 persons per year, or an average of nearly one person every second day, lose their life by street accidents in London, and the number of those injured amounts to 8,000 per year.

My plea is then that to meet the requirements of the traffic of London what is wanted is not so much additional railways, underground or overground, traversing the town and connected with the suburbs, but wide arterial improvements of the streets themselves. Railways which are strictly urban, or rather I should say trains which only traverse the town itself through carrying immense numbers of passengers, have not dealt with the question and will not produce the desired result in relieving the streets; on the contrary they tend to add to the congestion from the point of view of both urban movement and suburban influx.

It is an open secret that if the underground railways could only rely on strictly urban passengers, they would be nearly bankrupt. A reason for this is not far to seek. The urban journey is generally a short one, and when the little losses of time necessary to reach a station, catch a train, and to go from the station to one's destination are all reckoned, the omnibus which carries a man directly from one door to the other, at fares which are frequently cheaper than even a third-class ticket, is found the preferable mode of transport. The Metropolitan and the District Railways alone between them carry about 140,000,000 of passengers annually, but the bulk of this great traffic is not urban, but is of suburban origin, deposited in urban localities. Moreover we must take note of the fact that third-class traffic is in numbers ·78 per cent. of the whole traffic on the underground lines. This indicates that the great travelling public is one which scrutinises expenditure narrowly, and the fact implies that so long as omnibuses can carry people for penny fares, and still more if the halfpenny fares of Glasgow are introduced in the metropolis, the vehicular traffic of the streets will show more and more increase as compared with the journeys made from one part of the town to another by railways. But apart from these considerations, the extension of the underground railways into the suburbs more than counterbalances what relief they afford to the traffic of the streets by carrying strictly urban passengers.

I do not lose sight of the fact that the new Central London Railway, now nearly approaching completion, will be made under the existing thoroughfares of Oxford-street, Holborn, and Cheapside, but I do not think, from reasons already given, that any underground line can do very much to relieve the ever-growing traffic of the streets. No doubt the new railway will carry multitudes of people, but in the first place it will create a new urban and suburban traffic of its own, and, secondly, the experience of the Metropolitan and District lines is that surface transit for short distances continues to increase, in spite of the competition of the underground railways, even if it be not fostered by them.

I had written the above remarks as to the influence of railways before I read Col. Haywood's Report of 1867. I am pleased to see that his views entirely coincide with mine in this as indeed in other particulars.

In my judgment, the question of street improvements in London should be considered as a whole and in a large-minded way, unless we are to be doomed to perpetual disappointment. We should endeavour to enlarge our views of present requirements, and provide for our successors. A scheme of new main thoroughfares of adequate width for present and future traffic should be laid down, and this should be realised as time and finance will permit. It should be a scheme worthy of London, and such as that which was laid down by Sir Christopher Wren and published in 1666 for the renovation of the City after the fire of London, but unhappily laid aside; or as was designed for the improvement of Westminster, presented to the public by my father, Sir Charles Barry, in 1857, and published in the memoir of his life.

There should be continuity of effort towards radical amelioration, by the construction of great main lines of through communication as distinguished from merely local improvements; and all local improvements should, as we have seen in Paris and other foreign cities, be so devised as to form parts of a harmonious whole. Thus I venture to think that the first thing to be done by our municipal rulers, is to realise what is wanted, and to employ the highest and most experienced talent of the age to lay down the best lines for arterial thoroughfares.

Much has to be done without delay, but it is not necessary to urge that the whole expenditure should be immediately or concurrently undertaken. The vital point is to endeavour to realise requirements and to make every

improvement which can be put in hand subserve the purposes of a thorough conception of the problem of how best to deal with the traffic of London in the great streams from east to west and from north to south.

Apart from wide streets, a matter which has been too much lost sight of, is the provision of means for allowing the north and south traffic to cross the east and west traffic with the least possible confusion. With the exceptions of the north approach of London-bridge crossing Thames-street, of the famous Highgate Archway, of the Holborn-viaduct improvement undertaken by the Corporation of London, and of the arches which carry the south approaches of Waterloo, Blackfriars, and Southwark Bridges over a road which closely adjoins the river bank, there are no means of such crossings in London otherwise than on the level. The Holborn-viaduct, and the streets leading to it, form collectively a very fine and creditable work, and they have been an enormous benefit to Londoners. The value of the undertaking can only be appreciated by those who remember the steep slopes of Holborn-hill and the continual congestion of traffic, in consequence of the level crossing of Holborn and Farringdon-street.

A very easy and obvious improvement of this nature, on a small scale, could be readily effected by passing the north approach to Southwark-bridge over the crowded thoroughfare of Upper Thames-street.

If some means could be devised for the crossing of north and south traffic over or under the east and west traffic at such places as Hyde-park-corner, Piccadilly-circus, Ludgate-hill, the south end of Tottenham-court-road, and Wellington-street (Strand), the relief to the main thoroughfares at the spots in question would be enormous.

For example, a scheme is now being promoted for a new street from the Strand to Holborn, in a line, or nearly so, with Waterloo-bridge; but its utility, great as it may be in itself, will be to a great extent marred if no means are provided for dealing with the traffic from the south of the Thames by Waterloo-bridge, and crossing the Strand, or coming from the north, and crossing Holborn, otherwise than interjecting it athwart the east and west traffic in those crowded thoroughfares.

Of course, all such works would be very costly, for they involve not merely the crossing itself of leading thoroughfares by means of bridges and viaducts with approaches of about 1 in 40, but the connection of the streets on the level must, of course, be also maintained, so that traffic desiring to join the streets at right angles on the level might be able to do so. The results would, however, be well worth the expenditure, heavy as it might be, and I venture to contend that as in the case of the provision of wide arterial streets, the improvements of right-angled level crossings by means of sunken or raised roads and bridges ought not to be put aside as impracticable because they involve the same difficulty of cost. In this they would be as efficacious in their way of systematically meeting the wants of London as the other more obvious work of widened thoroughfares, while they possess this advantage, that they could be put in hand at once without waiting for the completion of the great through routes. There is no reason whatever why such works should be unsightly; on the contrary, they might be made highly artistic, and be architectural embellishments of London. When we contemplate what has been voluntarily spent by railway companies in getting rid of junctions on the level for similar advantages to their main lines of traffic, and when we remember the expenditure which is properly laid upon them by Parliament when they carry their lines across public streets, the outlay necessary for providing over or under crossings for the enormous vehicular and pedestrian traffic of London ought not in itself to be considered prohibitory.

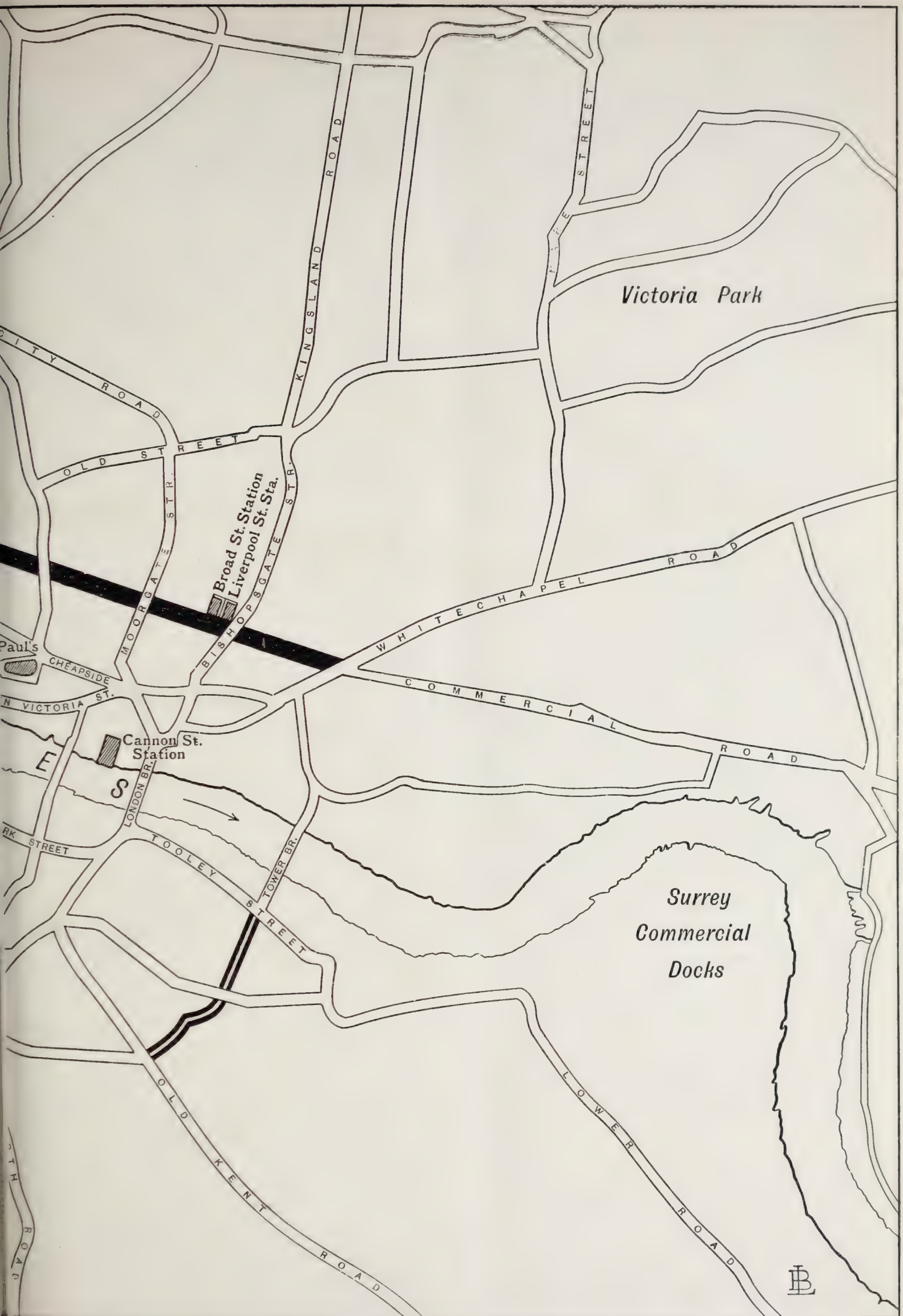
The mode of executing such works would require much study, and different crossings would have to be dealt with in different ways. I have given some consideration to the subject at the points above mentioned, and I can say that there is nothing impracticable in the suggestion, and I feel confident that such improvements would be really worth their cost.

Approaching now the question of improved arterial streets, I cannot but feel that to lay down any good plan for dealing with the main lines of traffic of London must involve much study. I should be rash to do more than roughly indicate what I think should be aimed at.

There are three main lines of east and west traffic on the north side of the Thames, viz., those of Euston-road, Oxford-street, and Piccadilly, together with the Strand, all of which urgently call for remedial measures of a drastic character, but before discussing the north side of the river I should like to say a few words on the

Suggested New Streets and Improvements in solid black lines.

New Streets proposed by the London County Council thus:-............



ap to illustrate suggested New Thoroughfare and Street Improvements.

Scale of Miles

Chains 80 60 40 20 0 ½ 1 Mile

Walker & Boutall sc.

thoroughfares of the south side of the Thames. They certainly merit full attention, though, as a matter of fact, I think that the general urgency there apart from one or two special points is not at present so great as on the north side.

Dealing, then, with Lambeth, Southwark, and Bermondsey, we notice that, owing to the great bend of the Thames between Vauxhall and Bermondsey, the direction of the main lines of traffic on the south side of the river is radial, with a southernly trend, as distinguished from the chief lines of traffic on the north side of the river, of which we know the main direction is east and west.

Owing also to the fact that the bridges of London have, with the exception of London-bridge, been all built within the last 150 years, the roads leading to them are wider, and more adequate to modern requirements than the older streets of the north side. Again, in consequence of the roads being, as I have said, radial, there is no such pressure of traffic on the south side along two or three routes as we see on the north side of the river, except where three of the bridge roads bring their traffic more or less to one point near the "Elephant and Castle," from which it again disperses.

At this spot the congestion is frequently serious, and it will doubtless become worse. No doubt some improvement is required near the "Elephant and Castle," which should have for its object the separation of the at present converging streams of traffic before they reach the present point of concentration.

Although, as I have said, the chief lines of traffic are radial, it is right to remember that there is a very considerable stream of traffic to be accommodated on the south side of the Thames, which passes generally east and west, though following the bending course of the river. To deal with this traffic brought into London by the Wandsworth and Stockwell roads we have, starting from the west, the Albert-embankment, 85 feet wide, made by the Metropolitan Board of Works at a cost of £1,014,000, the old streets of the York-road and Stamford-street, 60 feet wide; Southwark-street, a comparatively new work, 70 feet wide, made in 1864 by the Metropolitan Board of Works at a cost of £366,000, ending in the overcharged thoroughfare of the Borough.

When all these streets are considered, we cannot but see again the inevitable blots of piecemeal undertakings. We find that the widths are designed in a haphazard way, that where the route ought to be wide, as at the access to Waterloo Station, it is narrow, that the eastern end of Southwark-street is only connected with Tooley-street, by which the route is continued further eastward by narrow and tortuous lanes, or by the alternative route of a nearly double right-angled corner, involving also very steep gradients up to and from the south end of London-bridge and to Duke-street. Added to these disadvantages, the east and west stream of traffic has to cross on the level all the routes north and south from Vauxhall, Westminster, Waterloo, Blackfriars, Southwark, and London bridges.

Anyone who knows the Westminster-bridge-road and York-road and Waterloo-bridge-road, on a busy day at Waterloo station, when the traffic is blocked as far back as Parliament-street, or is acquainted with the continual and vexatious stoppages which occur at the crossings of Blackfriars-road and at the Borough, will recognise, first, that the east and west routes on the south side of the Thames have been laid out from time to time as merely local improvements, and without any grasp of the necessity for a main trade route approximately parallel to the river bank, and, secondly, that before long these imperfect means to an end must be extended, straightened, and widened on a more adequate basis.

Leaving the southern side, I will now refer to what I recognise as of more importance and urgency, viz., the north bank of the Thames and the three main lines of east and west traffic. There are the Euston-road (in which term I include Praed-street, Chapel-street at the west, and the Pentonville and City roads at the east); Oxford-street (in which term I include Uxbridge-road, Bayswater-road, Holorn, Newgate-street, and Cheapside); and Piccadilly, with the Strand (including Fleet-street, Ludgate-hill, Cheapside, and Cannon-street). I venture to submit that all these are almost ludicrously inadequate to what is wanted.

The Euston-road route is less glaring in its shortcomings than is Oxford-street, and the Oxford-street route is better than the Piccadilly and Strand route. It appears to me that in respect of all three routes there can only be a choice between greatly widening the routes themselves or making parallel streets.

In the case of the Euston-road, the widenings and improvements which would be necessary are less long and involve less serious consequences than in the other

thoroughfares, and one would think that if a bold widening of Praed-street and Chapel-street, a connection of Junction-road by a wide direct street with the Bayswater-road, near Victoria-gate, some considerable widening from Chapel-street to beyond Baker-street, so as to include the two important railway stations of the Great Central and Metropolitan companies, if another bold widening were made from Albany-street to Gower-street, an avoiding parallel street from Chalton-street to Rodney-street, so as to leave the existing road as an access to the Midland and Great Northern Stations, and if at the east end of the line a more convenient connection were made with Old-street, this northern line of communication east and west through London might serve for some years to come. I am purposely leaving out here allusion to the crossings of the north and south streams of traffic, which subject I have already discussed at some length.

When we turn to the Oxford-street route, we are face to face with a more important line of traffic and one more crowded than the Euston-road route. Coming from the west, we may, I think, say that with the exception of some narrow places near Notting-hill-gate Station, and to the confused crossing of Edgware-road and Park-lane, the Oxford-street route is fairly adequate as far east as Edgware-road, having regard merely to the present traffic on the portions in question. But from that point a radical improvement, either by means of important widenings or by a new street, is wanted which should be carried through the City so as to connect at its eastern end with the Mile-end-road, and form a wide thoroughfare through the very heart of London on the north side of the Thames. Such a street, so far as the City itself was concerned, was proposed by Colonel Haywood in 1867, who stated that he limited his design to the City because of the conditions of his appointment being confined to its jurisdiction.

It appears to me that electric tramways on the surface of the ground are what will be wanted in the near future of London, on at least one great through route east and west, and on two, or perhaps three routes north and south. We have, I think rightly, in view of the narrowness of our streets, stopped the tramways south of the Thames and at the Euston-road, but it cannot be doubted that this necessity is most unfortunate for the welfare of the poorer classes of the metropolis.

It is also obvious that any such accommodation, however desirable, cannot be afforded by any street of the width of the present Oxford-street and Holborn.

Another want also which is beginning to be pressing, is a route for bicycle traffic. One cannot but recognise that the bicycle, as a means of rapid and cheap locomotion, is a new endowment to mankind, and it is difficult to realise what an advantage it would be to the bulk of Londoners if they could travel safely and at perhaps eight or ten miles an hour, on their bicycles from their homes to their work and back again.

Apart from the almost universal use of bicycles for general traffic, we see already, in country districts, artisans going to their work and returning homewards on their bicycles, covering by this means distances which were but a few years ago prohibitory. We ought not to be content that Londoners, and especially the working-classes, should be debarred from these facilities.

Two years ago I said in an address to the Institution of Civil Engineers that I looked forward to a time when bicycles would be as much part of a man's—and, doubtless, also of a woman's—equipment as a pair of boots, and from the progress which has already come about, I think that this was scarcely an exaggerated anticipation.

The present price of bicycles will not, I suppose, rule very long, and we shall see these admirable machines made at prices which seem now unattainably cheap. The proper application of machinery in the making of bicycles will result in the same reduction as it has occasioned in the manufacture of watches. The weight of a bicycle is so small that the value of the material (except the india-rubber tyres) cannot be serious. And if all the parts of a good machine-made watch can be manufactured and put together and sold for less than £1, the manufacture and putting together of a bicycle ought not to cost much more. If we add the cost of the steel and the india-rubber, it surely seems not too sanguine an estimate to suppose that a few years hence bicycles will be sold at about a fourth of their present price.

When this takes place, are Londoners to be debarred from their use by the fact that the streets are so crowded with vehicular traffic as to be too dangerous for bicycles? This will seem hereafter to be as absurd as a proposition that foot passengers ought not now to be accommodated in the streets because of the requirements of the vehicular traffic.

If these views of the future requirements of

London are correct, we want, in my opinion, one new and spacious thoroughfare east and west, about 120 feet wide, that is to say, as wide as Whitehall, opposite the Horse Guards. It might follow approximately the route indicated on the map, leaving the Bayswater-road near Westbourne-terrace, following the line of Wigmore-street to Russell-square behind the British Museum, thence to near Broad-street Station, and ending at the Commercial and Whitechapel-roads, as proposed by Colonel Haywood. In addition to this east and west artery, there should be two or three thoroughfares north and south, slightly less in width, which should be carried over the east and west route, by bridges at the points of their intersection, and all these new routes should have a raised or sunken road throughout for bicycles, so that they should not mix either with vehicular or pedestrian traffic. Communication between the streets and the sunken roads could be given by ramps at selected spots for bicycle access, and by steps, and stables for the bicycles could be provided at the level of the sunken road by excavations and enlargements similar to those of the admirable underground lavatories of modern construction, which are so great a boon to Londoners.

When one contemplates the cost of such a work as an arterial street 120 feet wide through the length and breadth of London, the prospect is, no doubt, somewhat alarming. A street of this kind four or five miles long, with side accesses and the works of construction, must mean many millions of money, though the recoupment from the frontages of such a new street would be very important. Such, however, is the kind of undertaking required for the London of the future, and if Paris can undertake the great streets to which I have referred, why should we take such niggardly views of what is really important for the public good of London?

Whether it would be cheaper to cut such a new street through the property north or south of Oxford-street and Holborn, or to widen those thoroughfares, would require much more study than could be given to the subject in such an address as this. My impression is that in the case of the central line of traffic, east and west, money would best be laid out in a grand new street, similar to one of the great Boulevards of Paris, rather than in any widening of such trading thoroughfares as Oxford-street and Holborn, Newgate-street or Cheapside, for in making an entirely new street the property to be acquired would have less present trading value, there would be much less disturbance of commerce than in widening an existing street, and the frontages to the new street would be of immense value hereafter.

We have discussed two out of the three east and west thoroughfares, and we come naturally now to that of the Strand, Fleet-street, and Piccadilly. In this case it seems to me that systematic widening of all these three thoroughfares is probably the only course to be adopted, together with a broad diagonal street from Piccadilly - circus, viâ Coventry - street, to join the widened Strand near the south end of Wellington-street, so as to avoid the right-angled bend up Waterloo-place and its steep ascent. In addition, some equivalent for the diagonal street from the Strand, near Waterloo - bridge, to the Thames-embankment, proposed in 1868 by the Metropolitan Board of Works, and laid aside from exaggerated reverence to the somewhat obscure Chapel of the Savoy, should certainly be made. It would be of the greatest use in relieving the western parts of the Strand. The new street, so long talked of, to connect the Mall with Charing-cross, and afford a direct route from Charing-cross to Buckingham-palace-road, and to Hyde-park-corner, viâ Constitution - hill, is another pressing necessity, and could very easily be put in hand.

Constitution-hill again urgently calls for widening, which could readily be done by the inclusion of the present bridle path on its east side. The bridle path could be moved a few yards into the Green-park, in which position it would be a very attractive feature of the park —a sort of miniature Rotton-row. The present bridle path is so narrow as to be dangerous, not only to equestrians, but also, in the London season, to the vehicular traffic of Constitution-hill. This improvement could be carried out without disturbing any of the trees, and it would form a fine and stately approach to Buckingham Palace from Hyde-park.

I fear that in the street improvements which I have sketched I shall be thought to have extravagant and utopian views, but when one contemplates the vast sums spent by railway and public companies to bring traffic to London, or realizes what has been done by continental nations to improve their means of transit in their capitals and to embellish them, I cannot see that Londoners should consider the cost of such measures in the metropolis of the kingdom and may I not say of the Greater Britain as prohibitory. I have above given an

indication that a wise and liberal expenditure on street improvements brings with it an immediate return in public convenience, though it does not appear in the same direct way as do fares paid to public companies for the use of their means of locomotion.

One difference attending continental improvements, as compared with those of this country, is that they are largely paid for by indirect taxation of octroi duties, while our only system, since the short-sighted repeal of the coal and wine duties, is that of direct rating. The money equally comes out of the pockets of the inhabitants, but our present system undoubtedly tends to cramp the views of our administrators. No doubt it is right that those who pay should have a directly preponderating voice in the expenditure. This they have here, and no doubt the electors narrowly scrutinise the rates, but I should not despair of educating the public of London to an appreciation of the value of good arterial means of communication so that those who favour them would not run the risk, which our local representatives so much dread, of being accused of extravagance when the day of re-election comes. Expenditure may be wise or foolish, and it is foolish expenditure on ill-considered schemes and piecemeal projects which should really be deprecated. At any rate let the subject have its due attention and let the best minds devote themselves to the problem which is urgent now and becoming intolerable.

All roads were said to lead to Rome. How much more do they now lead to London from every part of the civilised world. London is *par excellence* the city of Europe, Asia, Africa, and America. England is the home of our fellow subjects from every colony, and I think I may say also of many of our American Cousins. London is the richest city ever known and the most populous, but when this is acknowledged we have to admit that its streets are getting day by day, in spite of the improved means of transit afforded by underground lines, more and more impassable, and to look more and more mean, while we must further remember that in 33 years we shall be face to face with a population of at least 8½ millions in Greater London.

Is it not time then to approach the subject of its streets in a large-minded and systematic way, laying down the great principles to be carried out and working steadily towards a great result?

The expenditure involved, heavy as it no doubt would be, should not affright us. It would be repaid by the increased facilities both for trade and pleasure. London would be more attractive than it now can be. The stress of life would be lightened, and the saving of time to the millions using our streets would be enormous, though, as I have said, a money value to that saving cannot possibly be appraised. That saving would accrue to the poor even more than to the rich, for to the poor man who has nothing to sell but his labour time is of cardinal importance. The crowding together of our labouring classes would be diminished as better facilities of easy and cheap locomotion enabled them to reside in the outer ring of London, increasing their means of inhabiting healthy homes and adding greatly to the happiness of themselves and their families.

My ideas of what is wanted may be erroneous or imperfect—and I do not pretend to their being more than suggestive—but be that as it may, I cannot but think that the relief of the present congestion of our streets by a systematic and well-considered enlargement of the arteries of London, is a subject which must commend itself as of primary importance to the whole city—nay more, to the whole nation, and that it is one worthy of the fullest consideration by those who would devote themselves to no peddling treatment, but to such a large-minded plan of a remodelled town as was made by the great architect of the 17th century in respect of the City of London after the great fire; and as has been carried out so successfully in Paris, where I suppose the cost of land and of construction differ but little from similar values in London.

In conclusion, I have to acknowledge a great deal of assistance which has been rendered me in various quarters. The Foreign Office very kindly caused enquires to be made in several foreign cities, and have supplied me with much valuable information. Similar statistics have also been kindly provided by the Mayors of New York and Boston, to whom direct application was made. As there was a good deal more information than I could readily utilise in the course of this address, I have handed the papers over to the Editor of the *Journal*, in order that the statistics they contain may be published in form in the *Journal* at a later date.

The General Managers of the following rail-

way companies have been most obliging in furnishing me with statistics of their past and present traffic :—District, Great Eastern, Great Northern, Great Western, London, Brighton and South Coast, London, Chatham and Dover, London and North Western, London and South Western, London, Tilbury and Southend, Metropolitan, Midland, North London, and South Eastern. The Labour Department of the Board of Trade, the Commissioner of Police, the Public Health Department of the City of London, the Statistical Department, and the Engineers' Department of the London County Council, have indicated sources of information and furnished me with extracts from their official records. The Secretary of the London General Omnibus Company gave me some interesting particulars as to the past and present working of the Company. The Thames Steamboat Company have answered some inquiries as to the river traffic.

These and many others, have supplied me with much valuable material, some of which I have been able to utilise, but more I have been obliged to omit, having regard to the necessary limit in length of this address, and to my desire not to overburden it with dry statistics.

After the delivery of his Address the CHAIRMAN presented the Society's medals which have been awarded during the last Session.

For papers at the Ordinary Meetings :—

To PROF. JAMES DOUGLAS, for his paper on the "Progress of Metallurgy and Metal Mining in America during the last Half Century."

To SAMUEL RIDEAL, D.Sc., for his paper on "The Purification of Sewage by Bacteria."

To CAPTAIN B. F. S. BADEN-POWELL, for his paper on "Kites: their Theory and Practice."

To PROF. J. A. EWING, F.R.S., for his paper on "Linde's Method of Producing Extreme Cold and Liquefying Air."

To PROF. SILVANUS P. THOMPSON, F.R.S., for his paper on "Telegraphy Across Space."

To MISS CLIVE-BAYLEY, for her paper on "The Revival of Hand-loom Weaving."

To J. K. STARLEY, for his paper on "The Evolution of the Cycle."

In the Indian Section :—

To HERBERT MILLS BIRDWOOD, C.S.I., M.A., LL.D., for his paper on "The Plague in Bombay."

To HENRY LUTTMAN-JOHNSON, I.C.S., for his paper on "The Earthquake in Assam."

To SIR ALFRED COMYNS LYALL, G.C.I.E., K.C.B., D.C.L., for his paper on "Chartered Companies and Colonisation."

In the Foreign and Colonial Section :—

To NEVILE LUBBOCK, for his paper on "The West Indies and Sugar Bounties."

In the Applied Art Section :—

To J. HUNGERFORD POLLEN, for his paper on "Renaissance Woodwork in England."

To SIR E. MAUNDE THOMPSON, K.C.B., for his paper on "English Art in Illuminated MSS."

Sir OWEN TUDOR BURNE, G.C.I E., K.C.S.I., said he had much pleasure in asking the members to join him in a cordial vote of thanks to Sir John Wolfe Barry for his very instructive and interesting address. Many of the observations and recommendations had filled him with admiration, and some of the statistics had filled him with surprise, but the remarks with regard to the bicycle had filled him with terror. However, as they were precluded by the rules of the Society from raising any discussion on the address, he could only assure the Chairman that they all appreciated the valuable information he had given with regard to the metropolis; and he should like to add that he was sure they would all concur in the opinion that both the Council and the Society at large were proud of having so distinguished a man to preside over their deliberations.

Sir FREDERICK J. BRAMWELL, Bart., D.C.L., F.R.S., as senior past chairman of the Council present, had much pleasure in seconding the vote of thanks. He could not say much upon it, because Sir John Wolfe Barry was too great and too old a friend to allow him to form an unprejudiced opinion on the address, but if he had not known anything of him before that evening he should have cordially congratulated the Society on having at the head of its Council for the ensuing year, a man with so large a grasp of so important a subject.

The vote of thanks having been passed unanimously,

Sir J. WOLFE BARRY, in responding, said he had devoted a good deal of trouble to the preparation of the address, which he feared had occupied more than the usual time, and if it had been more than usually tedious he must apologise. He thought he might reassure Sir Owen Burne by saying that if his views of what was wanted in London were ever carried out, Sir Owen would be relieved from the dangers of bicycles, unless he took to riding one himself, because he (the Chairman) was not qnite so mad as to propose that vast numbers of bicycles should be sent careering through the crowded streets of London. He thanked the members for their cordial reception, and hoped they would have a successful session.

Miscellaneous.

THE COLONIES AND PROTECTORATES OF FRANCE.

The colonies that are under French rule have an area of 1,887,991 square miles and a population of 51,615,427. Their special trade with the mother country, *i.e.*, imports from home consumption and exports of domestic produce, amounts in value, according to the *Dépêche Coloniale*, to £30,300,000, made up as follows: Imports into France from the colonies, £15,972,000, and exports from France thereto £14,328,000. These figures are for the year 1897. The following statistics show the population, area, and annual foreign trade (imports for home consumption and exports of domestic produce) of the colonies and protectorates. The area of Algeria is 226,184 square miles, and the population numbers 4,429,421. The productions of this colony consist of cereals, flax, seed, vegetable fibre, iron ore, oranges, essences, red and white wine. The trade between France and Algeria for the year 1897 amounted in value to £18,164,000—£9,516,000 imports into France and £8,648,000 exports from France. The general trade with other nations aggregates £4,000,000, of which £1,700,000 represents exports from, and £2,300,000 imports into, Algeria. The largest article of importation into France from Algeria was wine, the value being £4,000,000. Among the exports from France to Algeria, the values are in the order given: Tissues, trimmings, and cotton ribbons, £1,200,000; tools, £340,000; furniture and objects in wood, £300,000, and woollens, £275,000. Algeria is composed of three departments, and the population is as follows: Algiers, 1,526,667; Constantine, 1,874,506, and Oran, 1,028,248. The area of Madagascar, with its dependencies, is estimated at 375,000 square miles, with a population of 6,000,000. The commercial exchanges between France and Madagascar were valued at £632,000—£108,000 in imports into France and £524,000 in exports from France. The articles exported from Madagascar to the mother country consist chiefly of rubber and raw gutta percha, phormium tenax, and vegetable fibres, and raw hides. The exports from France to Madagascar are composed principally of wines, machinery, tissues, ribbons, tools, and other metal wares, hides, and leather, brushes, buttons, and fancy goods. The area of Réunion is 1,600 square miles, and the population numbers 169,493. The trade with France amounted in 1897 to £976,000—£636,000 imports into France and £340,000 exports from France. The articles imported into Réunion consist principally of tissues, wines, fish, and metal wares, and the goods exported are principally sugar, vanilla, sago, jalep, and exotic fecula. The area of Tunis is 52,903 square miles, and population 1,600,000. The trade between France and Tunis in 1897 was valued at £2,116,000—£1,140,000 imports into the mother country, and £976,000 exports therefrom. The principal articles exported from Tunis are cereals, olive oil, wine, and sponges, and those imported are cereals, hides and leather, clothing, toys, fancy goods, tissues, machinery, and apparatus. Senegal has a population of 1,800,000. The trade with France amounts in value to £1,608,000—£792,000 imports into France from Senegal, and £816,000 exports thereto. The principal articles exported from the colony are earth nuts, gums, rubber and gutta-percha, and the imports are chiefly tissues, wines, clothing, and metal wares. The area of the Kongo is 418,750 square miles, with a population of from 12,000,000 to 15,000,000. Soudan has a population of 300,000. Dahomey and dependencies—area 7,500 square miles; population, 22,000. The area of Guadeloupe is 687 square miles, and the population is estimated at 167,099. The commercial exchange between this colony and the mother country in 1897 were valued at £960,000—£548,000 imports into France, and £412,000 exports therefrom. The principal articles exported from Guadeloupe are sugar, coffee, dye-stuffs, and rum and tafia. The imports are chiefly wines, tissues, leather and leather wares, ready-made clothing, metal wares, and fish (dried, salted, or smoked). Martinique has an area of 381 square miles, and a population of 181,599. The trade with the mother country was valued at £1,232,000—752,000 imports into France, and £480,000 exports therefrom. The principal articles exported from Martinique are sugar, molasses, brandy, cocoa and chocolate, and woods; while those imported are wines, tissues, clothing, hides, fish (dried, salted, or smoked), fancy goods, and metal articles. French Guiana has a population of 26,839. The trade with the mother country was valued at £460,000—£68,000 imports into France, and £392,000 exports therefrom. The principal articles imported into this colony are wines, leather goods, tissues, salted meats, and manufactures of metals. The colony of St. Pierre et Miquelon has an area of 94 square miles and a population of 6,300. This number is doubled during the fishing season. The exchanges between France and St. Pierre et Miquelon were £1,312,000—£1,076,000 imports into France, and £236,000 exports therefrom. Exports from St. Pierre consist chiefly of fish (dry, salted, and smoked) and fish oil. Cochin China has an area of 37,375 square miles, and a population of 2,034,453; Tonquin, an area of 56,250 square miles, and a population of 15,000,000. Annam has an are of 162,500 square miles, and a population of 6,000,000. Cambodia has an area of 75,000 square miles, and a population of 1,500,000. The commercial exchanges between France and Indo-China are valued at £2,104,000—imports into France £876,000; exports therefrom, £1,228,000. The principal exports from Indo-China are composed of rice, pepper, raw hides, exotic resins, cocoa, waste silk, volatile oil or essences, and albumen. French

possessions in India have an area of 196 square miles, with a population of 283,053. The exchanges between France and French India in 1897 were valued at £40,000—imports into France, £4,000; exports therefrom, £36,000. New Caledonia and its dependencies have an area of 8,117 square miles, with a population of 62,752. Tahiti has an area of 402 square miles, and a population of 24,418.

IMPROVEMENTS IN BRONZE CASTING.

At a meeting of the Société des Ingénieurs Civils de France, M. E. Maglin made a communication on the casting of bronze statues, in which he sketched the art of working in bronze from the earliest ages, while dwelling more particularly on the method of moulding known as the waste-wax process *(moulage à cire perdue)*. In recent times, he observed, several inventors had endeavoured to make moulds of gelatine, the results of which were not encouraging; but it was given to a French sculptor—M. Le Bourg—to devise a method perfect as regards the results obtained, and also the saving in labour.

The process in question depends upon the fact that gelatine, with the addition of glycerine and glucose, preserves a constant elasticity even when exposed to the atmosphere; and by its means a statue may be moulded in its entirety, being surrounded by an envelope, or covering, in two parts, which are detached with great facility, while producing moulds of remarkable sharpness. In this manner a wax *(une cire)* is obtained by a single pouring, the seam of the mould joint being easily removed, since it is upon soft wax that the retouching has to be effected. This done—by the ordinary methods of the waste-wax process—the statue to be reproduced is covered with slip *(barbotine)*; the wax is melted out; and the bronze is run into the mould after the jets and vents have been arranged. The specially original point about this method is that, while affording a considerable number of copies, absolutely identical, it is independent alike of the sculptor, the chaser *(ciseleur)*, and the bronze mounter.

M. Maglin also observed that M. Le Bourg had made other improvements, some for preventing cracks in the wax, and others for producing various patinas in a dry manner by oxidation. At the same time he showed a series of models in different stages of progress, for illustrating the details of the successive operations.

The president, M. Edouard Lippmann, asked if the method that had been described was public property, and if not, whether it was applicable to the same compositions of metal as those for other methods of moulding, to which M. Maglin replied that the method was not public property, and that it was applicable to the mixtures of metal usually employed, but the bronze could be cast at a greater heat.

To a question by M. J. Gaudry, whether the method was suitable for large statues, the author replied that, as the chief object of the method was to afford a considerable number of copies, it had chiefly been applied to statues of ordinary dimensions, although it had also been employed for others of greater size, while in theory there was no limit in this respect.

M. Périssé mentioned the case of a large equestrian statue which, instead of being cast in several pieces, and afterwards united by internal sockets *(manchons)*, was formed of one single cast piece, although the casting was effected in several jets or pourings. This was the statue of Etienne Marcel, intended for the Paris Hôtel de Ville, and shown—rough as it left the mould from the atelier of MM. Thiébaut Frères—in the wide central gallery of the 1889 Paris Exhibition, where it attracted great attention from connoisseurs. The method of producing this statue consisted in casting separately the ten parts, which could not have been cast all together in the ordinary manner without liability to fracture during contraction—viz., the four legs of the horse; the two arms, head, and legs of its rider; and also the horse's tail; and then in putting these ten parts in their proper places in the general mould in such a manner as to obtain, thanks to certain precautions, an intimate union of the metal, advantage being taken of the heat in the last bronze run for effecting the "firing on."

This method, which greatly simplifies the moulding while ensuring a better casting, had already been adopted with success for parts of existing statues that required changing; but, for the operation to succeed, it was necessary that the molten metal should circulate in sufficient quantity over the parts to be connected by fusion, for which object pockets, or jets, were arranged, the excess of metal being received outside the mould. Such precautions were taken for the equestrian statue above mentioned, in which case, however, there was this exceptional difficulty, that the firings-on or fusions, had to be effected at ten different points simultaneously. Indeed, the sockets *(manchons)* for each of these ten parts had been cast previously; and, above each socket, there had been arranged, in the general mould, a feeding pocket, which had furnished metal in excess for fusing the extremities of the ten parts. It is thus that the eleven parts of this equestrian statue only formed a single whole, which formed such a prominent figure at the last Paris Exhibition, although it is not this identical statue which was erected in front of the Hôtel de Ville, because the Paris Municipality insisted on strict observance of a certain clause in the contract.

In connection with an observation by M. Roget, that M. Le Bourg's method produced works of art differing widely from those to which the public are accustomed, and that perhaps a little educating up will be required before its delicacy is appreciated, M. Maglin expressed the hope that, inasmuch as reproductions by this method had already received the sanction of artists, they would eventually be

appreciated generally, and also raise the tone of public taste—to which one circumstance greatly contributed, viz., that perfect replicas could be obtained at a lower rate than heretofore.

In reply to a question by M. E. Badois, M. Maglin added that about one hundred reproductions might be made with one and the same mould, but that when the gelatine process was used such moulds only lasted for five or six castings.

ORANGES IN PARAGUAY.

Oranges are of prolific growth in Paraguay, being found everywhere, many growing wild. They are cultivated, however, on farms. The seed will bear five years after being planted. The orange flourishes all the year round except in January, February, and March, and a tree seven years old bears about 1,000 oranges. According to the American Consul at Ascencion the orange is one of the most generally used articles of food in Paraguay, forming a staple article for the poor, particularly in the country districts. Hogs are fattened on them, and orange-fed pork is stated to be very good. The exportation commences about the end of May and lasts till November. The boats are loaded all along the river, women with flat baskets on their heads carrying them on board. Most of the fruit is sent to Buenos Ayres and Monte Video. During the season an average of 300,000 oranges are exported. The orange is usually about three inches in diameter and is very weet. There are three classes, which might be mentioned, the ordinary Paraguayan orange, the mandarin, and the bitter orange. The first kind is described above; the second (mandarin) is very small and not as sweet as the first, but its pungency makes it popular. The sale of this orange is brisk and the price is remunerative. The third class is the sour, or bitter orange, from whose skin marmalade is made. There is also an extract made from its blossoms, and some Frenchmen are engaged in this business in Paraguay, which is said to be very remunerative.

THE TRADE OF THE CANARY ISLANDS.

The commercial movement of the Canaries has progressed in the last ten years at the rate of from £80,000 to £120,000 a year. From £720,000 in 1888, imports rose to £1,720,000. In these totals, however, the importation of coal is included; without coal the total in 1895 was £700,000. The economic development of the Canaries depends solely on the number of boats stopping at the ports, which promotes a larger importation of coal and a more extended sale of meat, poultry, vegetables, fruit, wines, &c. The exportation of early fruits and vegetables has been of importance in the last six years. Cochineal formed at one time the sole wealth of the Canaries. In 1889, its exportation amounted to £800,000; since that time the quantity has greatly diminished. The early fruits and vegetables from the Canaries are sent almost entirely to London and Liverpool. Tomatoes are exported in boxes of different sizes. As regards cultivation, the seeds are imported from England, sown in the months of August and September, and transplanted a month later into well-irrigated land. About 9,300 plants can be put in a fanagada or $1\frac{3}{4}$ acres. The potato crop is ready in December or January. Many landowners plant a second crop, which is ready for market in March or April. From October to May, two harvests can always be counted on, whatever may be the product cultivated. Both potatoes and tomatoes are remunerative, but the banana, when it is of good quality, gives the greatest profit. The ground yields eighteen months after planting; there are usually about 1,000 to 1,200 plants to the acre, and 150 bananas to the plant, with two harvests a year. There are seven sugar refineries, operated by steam, in Grand Canary Island, one at Teneriffe, and two on the Island of Palma. The vines produce well, and the wines, when made with care, rival the best known. The Canaries are famous as a health resort, from 2,000 to 3,000 visitors wintering in the islands.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian Lewes, "Acetylene." (Lectuie I.)
Chemical Industry (London Section), Burlington-house, W., 8 p.m.
Imperial Institute, South Kensington, $8\frac{1}{2}$ p.m. Mr. F. Lambert, "The Stalactite Caves of New South Wales."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. Francis Bond, "The Comparative Value of Documentary and Architectural Evidence in Establishing the Chronology of English Cathedrals."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. Carruthers, "The Plant Friends and Foes of the Farmer."

TUESDAY, Nov. 22...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. William Beedie Esson, "Electrical Transmission of Power in Mining."

WEDNESDAY, Nov. 23...SOCIETY of ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Forbes, "Long Distance Transmission of Electric Power."
Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. Charles Jones, "Scavenging — Disposal of House Refuse."
Japan Society, 20, Hanover-square, W., $8\frac{1}{2}$ p.m. Prof. Sakuye Takahashi, "The Art of Flowe Arrangement in Japan."

THURSDAY, Nov. 24...London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Canon Benham, "Richard Porson."
Electrical Engineers, 25, Great George-street, S.W., $8\frac{1}{2}$ p.m. Adjourned discussion on Professor Thompson's paper, "Rotatory Converters."

FRIDAY, Nov. 25...Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Prof. Henry Robinson, "Sewerage and Sewage Disposal."
Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. R. A. Lehfeldt, "The Properties of Liquid Mixtures." 2. Mr. L. N. G. Filon, "Certain Diffraction Fringes as applied to Micrometric Observations."

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FRIDAY, NOVEMBER 25, 1898.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, 1899, at 7 o'clock, by Professor F. Jeffrey Bell, M.A. (of the Department of Zoology, British Museum). The first lecture will be on "Hands and Feet," and the second lecture on "Some Ways in which Animals Breathe." The lectures will be fully illustrated with lantern slides.

Due notice will be given when the tickets for the lectures are ready for issue.

A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received. Subject to these conditions each member is entitled to a ticket admitting two children and an adult.

CANTOR LECTURES.

On Monday evening, 21st inst., Professor Vivian B. Lewes delivered the first lecture of his course on "Acetylene." The lectures will be published in the *Journal* during the Christmas recess.

FOREIGN & COLONIAL SECTION.

A meeting of the Committee of the Foreign and Colonial Section was held on Thursday afternoon, 17th inst. Present:—Sir Charles Malcolm Kennedy, K.C.M.G., C.B. (chairman); B. Francis Cobb, Sir Villiers Lister, K.C.M.G., Sir Westby B. Perceval, K.C.M.G., Hon. Sir David Tennant, K.C.M.G., with Sir Henry Trueman Wood, Secretary to the Society, and S. Digby, Secretary to the Committee. The arrangements for the new Session were considered.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 23, 1898; Sir John Wolfe Barry, K.C.B., M.Inst.C.E., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Aström, Carl A., 83, Cannon-street, E.C.
Baylor, Armistead Keith, 23, Cadogan-gardens, S.W.
Cole, Philip Henry, 20, Lessing-street, Honor Oak-park, S.E.
Courtney, Charles Frederick, Central Mine, Broken-hill, New South Wales.
Leach, Herbert Louis, 28, Leigham-court-road West, Streatham, S.W.
Magnus, Sir Philip, 16, Gloucester-terrace, Hyde-park, W.
Spencer, John W., Newbiggin-house, Kenton, Northumberland.
Strutt, Denner John, The Firs, Strawberry-hill, Middlesex.
Thomas, Richard Beaumont, J.P., Dennel-hill, Tidenham, Gloucestershire.
Van Raalte, Jacques, Holland-house, Broadwater Down, Tunbridge Wells.

The paper read was—

LONG DISTANCE TRANSMISSION OF ELECTRIC POWER.

By Prof. George Forbes, F.R.S., M.Inst. C.E.

This subject has been much talked about, but little has been done, and even at this moment there are few people who realise what a vast field there is in this way for investment of capital on a sound commercial basis. Hitherto people have been appalled at the capital required for copper conductors.

In the present paper I bring forward nothing new. I use the methods which have been used for shorter distances; and I do not propose to suggest the use of electric pressures which have hitherto been considered unattainable. In all cases it is assumed that the power is generated by a waterfall driving a turbine which rotates a dynamo machine. The electric pressure may be raised by transformers. It is then carried by bare copper conductors to a point perhaps hundreds of miles distant; the pressure may there be lowered. The current is then passed through an electric motor which drives stamps, or mills, or pumps, or hoists, &c.

In this paper there is no time to devote to consideration of different systems or kinds of machinery, or of replacing copper by aluminium. It is a plain unvarnished tale of the ordinary methods in use, extended to somewhat greater distances.

During the progress of the electric works at Niagara Falls, attention was much given to the economic problems involved in the transmission of electric energy to a distance. But in that case clearly the following financial conclusion ruled the conditions :—It is always more profitable to bring the works requiring power to the electric source of power than to transmit the power to a distance *provided*—and in most schemes this is a large IF—you can find consumers to come to your locality. At Niagara this seemed likely, and, consequently, distance transmission beyond 25 miles was considered undesirable in the first instance.

I am here as an advocate of very distant transmission in all cases where it pays, and I know that it will yield a splendid return in many cases that have come under my notice. In all cases it would pay if there were a demand for the power at suitably high rates.

To Gold Miners and other Users of Power.

Of all industries to which it is applicable, gold-mining is the one which has come mostly to my notice as wanting a continuous supply of power day and night, and often without any economical means of getting it except by electric transmission. In these cases it will often be profitable to the gold miner to pay a high price for his power.

The distances with which I have had to deal go up to 250 miles in India, New Zealand, and Egypt, and if the Rhodesia mines show generally such returns as the Geelong and Selukwe mines have done, I have shown that the power of the Victoria Falls may be economically transmitted in some cases to 500 miles, and pay well.

Waterfalls will be valuable assets in the future. At present the difficulty of using their power generally lies in the fact that there is no demand for power in the neighbourhood. Some industries, like those connected with aluminium and carbide of calcium, are ready to go considerably out of their way to plant their works near a source of power. There are not many such industries.

In 1893, I sat on a committee appointed by the Indian Government to see whether the water-power, incidentally created by the Periyar irrigation works, could be used for making aluminium electrically out of the corundum found in the neighbourhood, and for other purposes. We found that power could be generated very cheaply, but that the corundum was not suitable, and no other important demands for power were brought to our notice. Years afterwards, I found that the Mysore, Kolar, and other gold mines could easily be reached by the power, and save great cost in coal. Here we have a transmission of 250 miles which will pay well if the mines are likely to continue producing gold as they have done.

Another specially favourable case of gold mines is in New Zealand in the North Island. The Waihi mines already work their mills by electrical and water power, but there is no adequate supply of water in summer. At many of the other mines there are no roads, and power cannot be obtained. In 1896, I was asked to explore the Waikato River, in order to find the best site for developing power to be transmitted to all the gold mines on the Coromandel Peninsula near Auckland. I finally settled on the Haka Falls, near the centre of the island, with a transmission line of from 180 to 250 miles, 20,000 horse-power being generated to supply not only all the gold mines but every freezing works and factory on the North Island. I spent six weeks on the survey of sites for the works, and furnished plans which would already be executed, except for what I must call the dog-in-the-manger policy of the Government. The site was peculiarly favourable.

To take another case of gold-mining. I was engaged in 1895-6 on a project without water-power and a transmission of 300 miles as a maximum. The Coolgardie gold-fields are so far from a port that coal is very expensive, and water for the boilers could hardly be obtained. I found that it was actually more economical to generate power by steam-engines at the coast, where coal and water were available, and to transmit power all the distance electrically, rather than to transport coal which was otherwise a necessity in all cases as well as water in many cases. In this case the miners were prepared to pay as much as £180 per annum for the horse-power.

In 1894, before I had completed the first electric works at Niagara, I was asked by letter from Johannesburg whether it would be possible to transmit power from the Victoria Falls, on the Zambesi, to all the gold mines in Rhodesia, varying from 350 to 500 miles dis-

tance. At first I was inclined to throw the letter into the waste-paper basket. No one, up to that date, had, to my knowledge, seriously considered the financial aspects of so distant a transmission of electric power. But the letter required an answer; so I sat down to work out and quote some figures which should show the absurdity of the scheme. I had been supplied with maps and costs of fuel, &c., and in a short time I found, to my astonishment, that if the facts were as stated, the scheme was financially and electrically a sound one. I was assured that at least 10,000 horse-power would be required at the mines, and that from £70 to £100 per annum would readily be paid for the horse-power. Upon this I was asked to go to South Africa to negotiate with Mr. Cecil Rhodes and Dr. Jameson for a concession. They both appreciated the value of the enterprise to the country, and prepared a draft of the concession, which was only awaiting the sanction of the Chartered Company's Board when the Jameson raid and the Matabele rising closed negotiations. Here is a case where, if there be really good gold mines, it will pay handsomely to transmit electric energy a distance of 500 miles, provided the surveys of the Falls prove as satisfactory as the photographs do, and provided the fever is not an insurmountable obstacle.

At this stage let me point out to those unacquainted with the difficulty of obtaining power at some gold mines, that £100 per annum for each horse-power continuously delivered would readily be paid in many cases. Broadly speaking, the power required for rock breakers, stamps, &c., may be taken as being such that 1 horse-power mills 1 ton of ore per day—the value of the gold is, say, £3 or more per ton in a rich mine. I am not speaking of soft conglomerate like the Rand ore, where 1 horse-power mills two or three tons per day, but hard quartz. Now, when I speak of £100 per annum for a horse-power, this, at the rate of 1 ton a day means 5s. 5d. per ton of ore for milling expenses. There are plenty of places where they would pay double this.

You have now heard of a number of cases where gold mining can be assisted by long distance transmission of electric power, for which I have worked out plans and estimates. There are hundreds of other cases about which I could not speak with the same authority.

But while I expect that gold mining is the principal industry to be benefited, there are many others, the chief requisite being a continuous demand for power day and night. This is met by electro-metallurgical processes, but these can generally be brought to the power. It also includes irrigation, which in some countries wants power day and night, and, to a certain extent, throughout the year. The quantity of water pumped does not need to be perfectly constant, and this enables intermittent demands for lighting, railways, and factories, to be met by slight variations in the pumping. Thus the plant is always fully at work and earning its dividend.

In speaking these words I am naturally thinking of the utilisation of the Nile cataracts, upon which I have been engaged during the years 1897-8. My report on this subject is in the hands of the Egyptian Government, and is their property; but I am not divulging secrets when I tell you that the electric lighting of Cairo could be done cheaper by power generated at the First Cataract than by steam-engines at Cairo. The distance is 400 miles as the crow flies. Do not imagine that I propose lighting Cairo immediately in this way. The Government has far more important uses for the power, not only in the irrigation of the country as it is, but still more for the perennial irrigation which will be so much extended when the great reservoir designed by Mr. Willcocks, Sir William Garstin, and Sir Benjamin Baker shall be completed by Mr. John Aird. You may take it as certain that before long the cataracts will be harnessed and forced to assist in developing not only Egypt proper but the Sudan, and specially the Dongola province up to the Fourth Cataract, which, with efficient irrigation, may become the most fertile country in the world.

Higher up the Nile, I have not travelled or made surveys, but I notice that Sir William Garstin is undertaking a journey to Khartum and the Blue and White Niles to determine the value of the country there. A time will doubtless come when the Murchison and Ripon Falls will also be turned to account.

I trust that I have said enough to lead the users of power in certain industries, and specially gold miners, to see that it is well worth their while to look into the relative costs of steam and electro-hydraulic works, even when the transmission is for a distance of many hundreds of miles; and it will be seen that many a gold mine hitherto considered worthless because of the cost of power, will be valuable if there be water-power available within a few hundred miles.

I will now speak to the financiers who may think of taking up electric transmission.

To Financial Men.

The financiers in the City of London or elsewhere, who enable the projects of engineers to be carried out, even when they possess no technical knowledge, have a wonderful instinct by which they know the important points to be certain about before supporting a scheme with their money. Erroneous opinions on the engineering points may for a time prevail, but not for long.

Many examples of this insight might be given, but let us confine the matter to long distance electric transmission. I will give you four objections which are always raised:—

1. "Has electric power ever been carried to such distances as you speak of?" The answer is "No." But electrical practice is advancing by strides. In 1882, at Munich, Marcel Desprez earned great credit for transmitting electric power 35 miles and getting a return of 25 per cent. But, in 1891, 70 per cent. efficiency was obtained between Lanffen and Frankfort, the distance being 108 miles.

2. "Are you sure that no new electric difficulties will arise when you go beyond the 108 miles of transmission, which has been accomplished?" The answer is, "We are sure of this from the tests made at Frankfort." [Only one difference between short transmissions and the 108 miles from Lanffen to Frankfort was found to exist and it had been anticipated by me in preparing the Niagara works. In 1892, I laid it down as essential for the works at Niagara, in order to be prepared for long distance work and for other reasons, that the frequency of the alternations should be as low as the construction of a good dynamo would warrant. In 1894, the tests at Lanffen-Frankfort were published, showing that without this low frequency no good efficiency could be got from the long distance power transmission owing to the great self-induction of the line.]

3. The financier again asks, "Are not the losses by leakage on a long line insurmountable?" The answer is, "There is hardly any loss by leakage. There is loss of power used up only in warming the transmission lines." But this loss can be calculated accurately, and in those cases where the wasted power costs little enough, we are glad enough to waste it if it saves copper, which is the great cost.

4. The business man then asks, "Well, but if you allow a great loss of current in transmission, do you not require an enormous quantity of copper to carry the extra current which you have to generate?" The answer is that this is perfectly true if you allow the losses to be too great, but up to a loss of 50 per cent. on the transmission line you are always saving copper by having greater losses on the way. In fact, every engineer who has made a serious study of long distance transmission will bear me out when I say that the cases in which electric transmission will pay can be clearly differentiated from those which will not pay, and the whole question is principally one of £ s. d. Also, that all engineers will agree as to what is the principal item of expenditure, viz., the cost of copper under the conditions of existing practice. Improvements may reduce this cost, but cannot increase it; hence the financier may be very sure of the data of expense, and if he can be equally well assured of the data of revenue, he has before him everything required for forming a sound judgment. Let us take three cases.

1. Suppose a water-power is utilised for distant transmission of 200 miles to a gold mine where transport is difficult and the ore rich. Suppose that the miners are ready to pay £100 per annum for each horse-power delivered continuously to the stamps, &c.—I am taking what may be looked on by some as an extreme case, but there are many such places in the world—suppose that it is a gold field employing only 1,000 horse-power continuously, the gross income is then £100,000 per annum. This is a large sum, and will warrant a very large capital expenditure.

Now if it is a case in which 20,000 volts of electric pressure may be used, less than 900 tons of copper is required, after 50 per cent. has been added for self-induction, giving an inefficiency (inverse of efficiency) of only 1·4. Thus 1,400 horse-power will have to be generated at the waterfall end of the transmission line for 1,000 horse-power delivered at the other end—the gold mine. The hydraulic and electric machinery are not likely in a favourable case, even with costly transport, to exceed £14,000. The working expenses are small, and clearly the great thing to be considered is the cost of copper. This might amount to £80 per ton of copper laid, or £72,000. Very likely the whole cost would be under £100,000, which, with a maximum possible annual expenditure of £20,000, would produce a revenue of £80,000 per annum or 80 per cent. I am sure that actual cases exist where this might be done.

2. If the distance were 400 miles, all other things remaining the same, the only serious

difference is in the cost of copper, which rises to £288,000; and taking £32,000 for the other expenses, the capital expenditure is £320,000. If the annual expenses were £20,000, which seems impossible, the nett income is £80,000 or 25 per cent.

3. Suppose the distance still 400 miles, and all other things remaining the same, but only £50 being paid per annum for the horse-power; here we have still £320,000 of capital expenditure, and a nett income of £30,000 for 1,000 horse-power delivered, or 9 per cent.

Of course, it is understood that while cases can occur where these figures apply, each case must be examined on its merits.

Looking at the last case quoted, the delivery of 1,000 horse-power at 400 miles, using 20,000 volts (or 200 miles with 10,000 volts), the financier would say 9 per cent. was not good enough for such a venture. I will now show how he may get 40 per cent., using the same machinery, the same copper, and the same annual expenses. This leads me to say a few words to the great copper companies.

To Copper Merchants.

I have now the pleasure to lay before you a simple financial transaction which copper merchants or others would willingly make, and which may avoid the huge capital hitherto required by those who would transmit the power, and will increase the dividends on money spent on the transmission. What I propose is to divide the capital account into two parts, ordinary stock which may be looked upon as speculative, and bonds on the copper which would be as sound an investment as could be desired.

Taking the last case mentioned, the capital charges are—

	£	£
3,600 tons of copper at the extreme value of £75 a ton	270,000	
Putting it in place at £5 a ton	18,000	
		288,000
Hydraulic and electric machinery, &c.		32,000
Total capital required		320,000

Most of this capital is required for copper which may be taken away if the Company fails, and is an absolutely safe security.

	£
The value of the copper is	270,000
Cost of removal [uncalled capital]	18,000

On the £270,000 a mortgage may be raised, and 4 per cent. ought to cover the chances of a change of market value. Thus we have—

	£
Annual payment on mortgage	10,800

All we have done is to raise a mortgage on the best possible security. This might be done by the copper companies, who often have too much material in stock not paying interest, or the money could easily be obtained from independent capitalists. Let us now see what difference this has made upon the balance-sheet. The capital charges are—

		£
Putting copper in place		18,000
Hydraulic and electric machinery		32,000
		50,000
Annual gross receipts—1,000 horse-power at £50		50,000
Less annual expenses	20,000	
Mortgage on copper	10,800	
		30,800
Annual net receipts		19,200

or almost 40 per cent.

By this simple transaction we reduce the total capital required by the transmitters of power from £320,000 to £50,000 for 1,000 horse-power delivered, and we have increased the rate of interest from 9 per cent. to 40 per cent., which ought to satisfy most people.

This scheme I have laid before the manager of one of our largest copper companies, and he entirely approved of the general lines.

Before leaving this part of the subject, I wish to make it quite clear that none of the figures which I have given up to the present must be taken as applicable to every case that may arise; the cost of developing the power at a waterfall depends so much upon the height of the fall, accessibility, &c., that no kind of an idea can be given of the cost without some data to go upon. The costs used in the above calculation are over the mark for the most favourable cases, and the cost of copper is also too high. Another factor is the size of the works. The larger the scale the smaller is the relative cost of works.

All that I have tried to make clear is that if there be a large and continuous demand for the power, and if the value of the mechanical power to the gold miner or others is great, the distance to which it can be transmitted with financial success is not limited to one or two hundred miles.

To Engineers.

Up to the present date, financial men have not realised the value of long distance transmission. Engineers, too, have been so much engaged with electric lighting and traction that few have

devoted much time to its study. The last nine years of my life have been devoted almost entirely to electric transmission and the last four years to very distant transmission.

At present, there exist no printed tables for facilitating calculations, such as civil engineers possess in other branches of the profession. In the case of electric transmission, every engineer must prepare his own sets of tables and curves to work from. I have been compelled to work these out for myself in various units. In England, we use miles, tons, and pounds sterling. In America, the units are 1,000 feet, the pound avoirdupois, and the dollar. In Egypt, the metric system prevails. The flow of water, too, must be taken in cubic feet per minute, gallons per day, metres per second, the Californian "miner's inch," or the New Zealander's unit, which is called a "head."

You will believe then that I possess a mass of tables and curves, and these might be worth publishing if the time had arrived, which is not perhaps yet. During these years, however, my methods have gradually become so simplified that I venture to bring to your notice one curve in relation to the one special question of efficiency and cost of transmission lines. It is so simple in its present form through a gradual evolution that I cannot help thinking that it may be of use to others.

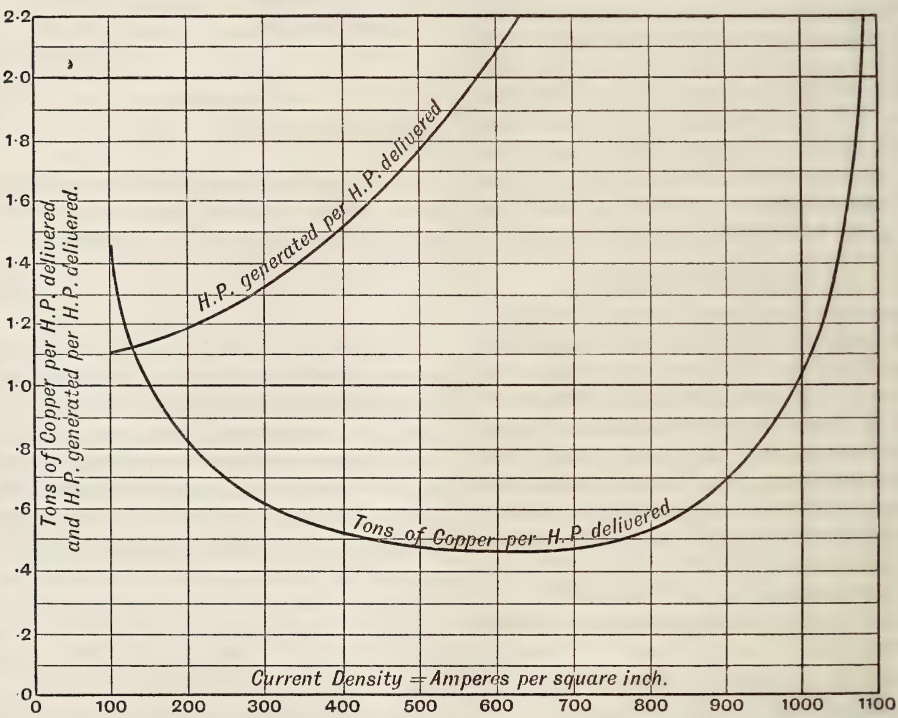
In transmission schemes the cost of copper becomes so all-important, when dealing with long distances, that it helps more than I can tell you to have simple means for estimating even roughly the cost and efficiency under various conditions.

I feel some diffidence in laying before you these methods because there is nothing new in the results, and all the results can be obtained by the ordinary methods. They have, however, been invaluable to myself. These methods are particularly useful for getting out preliminary estimates quickly.

Here let me say that in all preliminary work on the cost of long conductor lines, I never take notice of the resistance of the conductor, nor of the value of the current. I deal only with the current density, and loss of volts. It is the same thing under a different name. But it is what you want.

Again, I never use, in calculations for my own use, the efficiency of the conductor system. It is far more convenient to use the in-

FIG. 1.



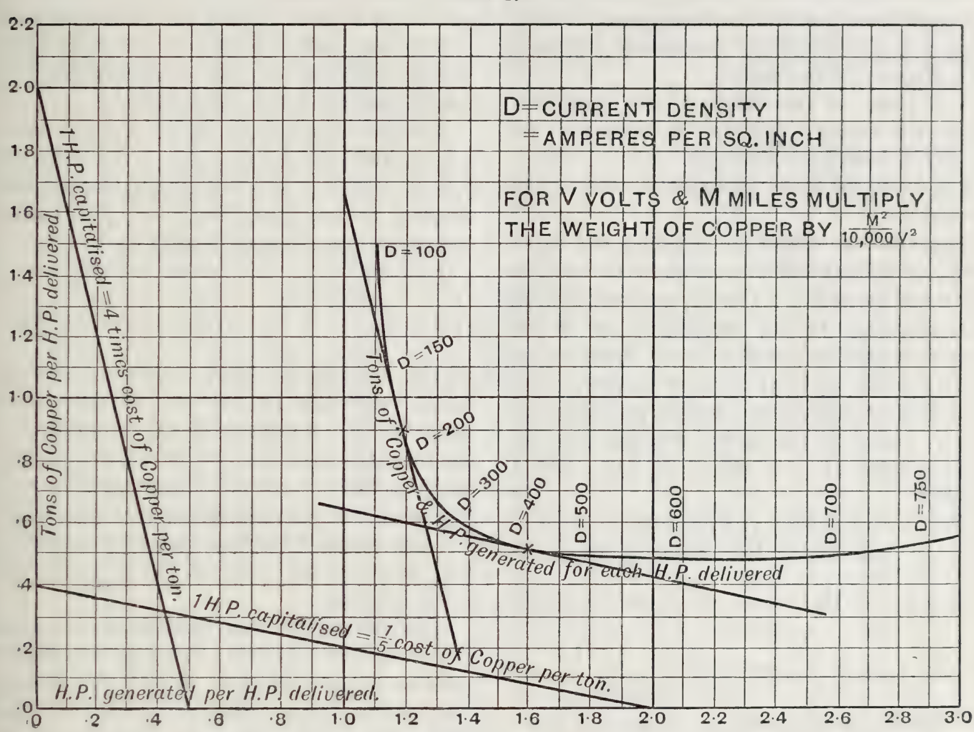
ELECTRIC TRANSMISSION CURVE FOR 100 MILES AT 10,000 VOLTS CONTINUOUS CURRENT

efficiency, or the reciprocal of the efficiency, which is also the horse-power put into the generating end of the line to deliver one horse-power at the other end.

I give you these suggestions for what they may be worth as the result of long experience.

I suppose everyone present is aware of the fact that if you had a case where the power cost absolutely nothing, you would use the least copper and have the cheapest arrangement, with an inefficiency of 2, *i.e.*, an efficiency of 50 per cent., or 2 horse-power generated density until the efficiency is 50 per cent., and then rises. This figure shows the weight of copper required per horse-power delivered at a distance of 100 miles at 10,000 volts. It is drawn for the simplest case of continuous current, to which corrections only for temperature and sag have to be made. It is equally applicable to a single phase or two phase alternating transmission to 100 miles at 10,000 effective volts; or at 5,000 effective volts from any wire to the middle of the electric system, or to three phase transmission to 100 miles at 5,000 effective volts

Fig. 2.



Electric Transmission Curve for 100 Miles at 10,000 Volts Continuous Current.

for each horse-power delivered. If you make the current density either greater or less than what is required to produce this inefficiency, then you have to use more copper to deliver the same quantity of power.

This is a point which in a general way is appreciated by the business man who is not an electrician, as has been already stated.

Fig. 1 shows this very well, and a study of it is interesting. We see that the copper required to transmit 1 horse-power 100 miles, at an initial pressure of 10,000 volts, with continuous current, falls with the increase of from any wire to the middle of the electric system. But with alternating current corrections must be made for self-induction and capacity.

The same remarks apply to the meaning of the voltage of the line in all the curves and tables referred to. They are worked out for continuous current, and for any other system the engineer must add the usual corrections.

Another curve may be drawn showing the inefficiency at each current density. This curve constantly rises, *i.e.*, the greater

the current density, the greater is the inefficiency.

Now from these two curves we can deduce a third curve, which is the one which I find gives one in a few minutes all the main facts one wants for any horse-power to be delivered to any distance at any initial volts.

This curve gives the tons of copper per horse-power delivered at 100 miles with 10,000 volts, continuous current, in terms of the horse-power generated per horse-power delivered.

Measuring along a horizontal line you get the inefficiency, *i.e.*, the horse-power generated for each horse-power delivered; and measuring vertically you get the corresponding tons of copper required for each horse-power delivered, at a distance of 100 miles.

The curve is also marked with figures to show the current density, in amperes per square inch section of copper.

I never travel a day without this curve in my pocket.

This curve is correct for 100 miles and 10,000 volts, or for any other case where the volts = 100 times the miles. The curve shows you, for example, that for an inefficiency of $1\frac{1}{2}$ you require a current density of 387 amperes per square inch, and ·55 tons of copper. And thus current density and weight of copper per horse-power is the same, whether you use 10,000 volts at 100 miles or 100 volts at 1 mile.

For any other volts and distance in miles, V and M, you divide the volts by the miles and get $\frac{V}{M}$; then $\frac{V}{100M} = D$, the multiplier for the current density, and $\left[\frac{V}{100M}\right]^2 = T$ the divisor, for the tons of copper per horse-power.

As an example, 15,000 volts and 300 miles. Here $D = \frac{15,000}{100 \times 300} = \frac{1}{2}$. Hence for an inefficiency as above of $1\frac{1}{2}$, the current density will be $\frac{1}{2} \times 387 = 198$. The tons of copper per horse-power will be $\frac{\cdot 55}{(\frac{1}{2})^2} = 2{\cdot}20$ tons.

Now let me show another use of the curve. Suppose we capitalise the cost of running the generating station, and add to it the cost of the generating works, and divide by the horse-power, we have then the capitalised value of 1 horse-power generated; I will call it for short the value of 1 horse-power generated. We also know the cost of one ton of copper. Divide the value of the horse-power by the value of the ton of copper, and draw a line across the axes so that it cuts the axes in that ratio. Draw a line parallel to this and touching the curve. This gives you, according to Lord Kelvin's law (as modified by Ayrton and Perry) the point of maximum economy giving directly the inefficiency, the tons of copper per horse-power and the current density. Thus on the curve two examples are shown, one where the value of 1 horse-power is four times that of a ton of copper. In this case the greatest economy is got by an inefficiency of 1·18, a current density of 180 amperes per square inch, and 0·91 tons of copper per horse-power delivered at 100 miles distance, the initial pressure being 10,000 volts.

Another example is shown on the curve where the horse-power is $\frac{1}{5}$th of the cost of a ton of copper. The resulting values are seen directly to be—Inefficiency = 1·58; current density = 420; copper = 0·51 tons.

To do this for other values of T $\left[T = \left[\frac{100M}{V}\right]^2\right]$ you must divide the value of the horse-power by T. Measure this distance vertically by the unit on the vertical scale or by fractions of these units, and measure the cost of a ton of copper horizontally by the unit on the horizontal scale or by the same fraction as before of that unit. Join the two points by a line and draw a parallel line touching the curve at the point of maximum economy.

You will see now how valuable such a curve must be for obtaining the very information that an engineer requires in his first examination of any project. But we can do more than this. Divide the tons of copper per horse-power by eighteen times the distance in miles, and you get the sectional area in square inches of the conductors (go and return) per horse-power. Multiply this by the total horse-power to be delivered, and you get the size of your conductors.

N.B.—Remember that this is all worked out for continuous current, and must be corrected for other systems as well as for temperature and sag.

Some people prefer to work by tables instead of by curves, so I will put down the readings of the curve which we have just been discussing. For ordinary work the following is sufficient:—

Inefficiency.	Tons Copper per horse-power.	Current Density.
1·20	·86	190
1·30	·66	266
1·40	·58	330
1·50	·55	387
1·60	·51	432
1·70	·49	475
1·80	·48	510
1·90	·472	545
2·00	·470	574

In most practical cases, however, the economical inefficiency for long distance transmission, lies between 1·20 and 150. The following Table gives closer values over this range:—

Inefficiency.	Tons.	Density.
1·20	0·86	190
1·22	0·80	207
1·24	0·76	221
1·26	0·72	236
1.28	0·69	250
1·30	0·66	266
1·32	0·64	279
1·34	0·62	292
1·36	0·60	306
1·38	0·59	319
1·40	0·58	330
1·42	0·57	342
1·44	0·56	354
1·46	0·55	365
1·48	0·54	376
1·50	0·53	387

From either of these Tables, having given the inefficiency, to get the density for any volts and distance, multiply the above value by $\frac{V}{100M}$, and to get the tons of copper, divide the above value by $\left[\frac{V}{100M}\right]^2$

This little Table enables us then, with a very simple piece of arithmetic, to get the result for any case that may arise, sufficiently close.

But in actual practice I find it far more useful to have the Table extended in such a way that an approximate result may be arrived at without any calculation.

Three Tables are here given. The first gives a reference letter for any volts and distance. In the second and third Tables the results we want are found under that reference letter. The second Table gives the tons of copper per horse-power delivered, and the third gives the current density for any inefficiency that we may select.

Rules for Using the Tables.

Rule I.—*To find the reference letter.*—In Table I., in the column referring to the volts generated, find the approximate distance of transmission in miles. The capital letter at the beginning of the line in which this is found is the reference letter.

Rule II.—*To find the tons of copper per horse-power delivered.*—Look along the row in Table II. referring to the reference number, and tons of copper are there given for each inefficiency. The inefficiency being the horse-power generated to deliver the horse-power at the distant point.

Rule III.—*To find the current density.*—Table III. gives this in amperes per square inch in the row corresponding to the reference number, and in the column corresponding to the inefficiency chosen.

Rule IV.—*To find the economical conditions of working* (*Kelvin's law*).—Divide the capitalised value of one horse-power by the cost of 1 ton of copper. Divide this by 10 and call it q. In Table II. look along the row corresponding to the reference letter until the difference between successive numbers is approximately q. The number at the head of that column is the economical inefficiency, the tons are also then given, and the current density is obtained directly in Table III.

Rule V.—*To find the total section* (*go and return*) *of all the transmission conductors.*—Multiply the tons per horse-power by the total horse-power, and divide by 18 times the distance in miles. This is the result in square inches. Dividing this by the number of conductors gives the sectional area of each.

Table I.—Distance of Volts.

Virtual Volts between Wires.						
1 or 2 phase ...	5,000	10,000	15,000	20,000	25,000	30,000
3 phase ..	4,325	8,650	12,975	17,300	21,625	25,950
Distances in Miles.						
A	12·5	25	37·5	50	65·5	75
B	25	50	75	100	125	150
C	37·5	75	112·5	150	187·5	225
D	50	100	150	200	250	300
E	62·5	125	187·5	250	312	375
F	75	150	225	300	375	450
G	87·5	175	262·5	350	437·5	525
H	100	200	300	400	500	600
K	150	300	450	600	750	900

TABLE II.—TONS OF COPPER PER HORSE-POWER DELIVERED.

Inefficiency.	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2·0
A	·0537	·0412	·0362	·0344	·0319	·0306	·0300	·0295	·0294
B	·2150	·1650	·1450	·1375	·1275	·1225	·1200	·1180	·1175
C	·4837	·3725	·3262	·3094	·2869	·2756	·2700	·2655	·2644
D	·8600	·6600	·5800	·5500	·5100	·4900	·4800	·4720	·4700
E	1·344	1·031	·9062	·8594	·7969	·7656	·7500	·7375	·7344
F	1·935	1·499	1·305	1·237	1·148	1·102	1·080	1·062	1·058
G	2·634	2·020	1·776	1·684	1·562	1·504	1·470	1·446	1·439
H	3·440	2·640	2·320	2·200	2·040	1·960	1·920	1·888	1·880
K	7·740	5·940	5·220	4·950	4·590	4·410	4·320	4·248	4·230

TABLE III.—CURRENT DENSITY.

Amperes per square inch.

Inefficiency.	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2·0
A	760	904	1,320	1,448	1,728	1,900	2,040	2,180	2,296
B	380	452	660	724	864	950	1,020	1,090	1,148
C	253	301	440	515	576	633	680	727	765
D	190	226	330	387	432	475	510	545	574
E	152	181	264	310	346	380	408	437	459
F	127	151	220	258	288	317	340	363	383
G	108	129	188	221	246	271	292	311	327
H	95	113	165	193	216	237	255	272	287
K	63	75	110	129	144	158	170	182	191

I trust that I have not wearied you with these arithmetical conundrums. All I can say is that I have found them of the greatest use, and I shall be very pleased if some of you do so also.

I trust that all here present who are not engineers realise now that the cost of transmission of electric power to a distance is a pure question of balancing expenditure and profits. By the methods now described, or by the ordinary methods, there can be no question as to the cost of the work. The only point in fact affecting the cost which has been left to the choice of the engineer is the electric pressure to be used, and every engineer in reporting on a scheme generally gives his reasons for selecting the pressure. In old days the highest pressure for which we could get a guarantee from contractors was used. But the expense of insulation increased so much with increase of pressure that now, as at Rheinfelden, we work to that pressure which is the most economical. Manufacturers will now guarantee any pressure if you will pay for it.

Having now determined with sufficient accuracy the cost of the works and their maintenance, annual expenses and interests on mortgage; the next thing is to see (or perhaps this ought to be the first matter attended to) what return can be obtained for the power delivered to a distance. It is then for the purely financial men to say whether the profits to be derived are worth the venture.

It has been my object to-night to put before engineers some useful rapid methods for arriving, on the ordinary lines of working, at the data for any special case of long distance transmission of power. It has also been my object to show that those who carry out such schemes do not require to be handicapped by the enormous capital which has hitherto been generally considered necessary. Incidentally it would appear that whenever gold mines exist which can afford to pay 5s. or 6s. per ton of ore milled, and if there be good water-power within

400 miles of the mines, it is most probable that it will pay well to transmit the power electrically.

If I have convinced any doubters that simply in my limited experience I have found many cases where it will pay well to transmit power to distances of several hundred miles, then my purpose is served, and I shall be glad that I have brought this subject to your notice.

DISCUSSION.

The CHAIRMAN said there were two matters of which there could be no doubt—first, that Professor Forbes had brought forward a most suggestive and valuable paper upon a subject which was pressing on the minds of many people in all parts of the world; and secondly, that engineering was a most delightful profession. He was sure all those who belonged to it would agree with him, and those who did not belong to it, after hearing this paper, would be more envious than ever of those who did. The profession of the civil engineer had been defined as that of one who directed the great forces of Nature for the use and convenience of man, and engineers were brought into contact with so many interesting subjects, localities, and people, that they were all happy to belong to such a profession. One of the matters which pressed on the mind of the engineer was the conservation of energy. It might take the form of capturing the power which existed in and came from the clouds in the form of rain, and was found in rivers or stored in reservoirs; it might harness the winds, and make them serve the use of man; proposals had even been made to capture the force running to waste in the waves; and there was the very seductive proposal of directly capturing the electricity in the air, due to terrestrial magnetism or electricity. All these subjects were germane to the interesting question brought forward that evening, because in so many cases the conservation of energy was not of much use unless there were also the power to transmit it to the place where it could be used. For instance, in Scotland, the valley of Ben Nevis had a rainfall of 10 feet per annum, which represented an enormous force at present unused. If that could be captured at a reasonable cost for storage, and transmitted to a distance, what a great future seemed to lie before future generations. It was rather startling to hear of £100 being paid per horse-power, but figures had been given showing that gold mining could afford to pay even that figure. In England one expected to get horse-power at £5 or £6 per annum by the storage of water, but he would not go into those details, nor yet into the financial question, except to suggest that the idea of a mortgage at 4 per cent. on copper, which was spread over 400 miles in Central Africa, seemed to him rather hypothetical. No doubt the value of the copper was there, but whether capitalists would be ready to lend money on it at 4 per cent. under those circumstances he had some doubt about it. He was not an electrician, and would not attempt to follow the figures and diagrams, but they seemed to be of the greatest possible value to those who had to deal practically with this subject, and they must all be grateful to Professor Forbes for giving them such means of forming a judgment on the problem which was at first sight so intricate, as that of the transmission of electric force for distances of 400 or 500 miles.

Colonel GOURAUD expressed his regret that there was not as large an audience to hear this paper as thronged the room and its approaches some years ago when he read a paper on the Phonograph, and said he thought the present subject, if not at first sight so fascinating, had more money in it, and it was a great pity the hall was not filled with capitalists and financiers. He was glad to be again in England, after an absence of some years, and he well remembered, about four years ago, meeting Professor Forbes at Niagara Falls amidst a crowd of the greatest men of science and finance of both hemispheres gathered together in connection with the great scheme of utilising that enormous water-power for the creation of electric energy to be transmitted at a distance of 25 miles to Buffalo. Three years later he found himself again —one Sunday evening—at Buffalo, and heard as a secret that that night the long-looked for transmission of power was to take place. He at once telegraphed to Niagara for permission to be present, but it was not accorded, and he then cabled over to *The Times*, got authority from the editor to represent the paper on the occasion, and ultimately, after some difficulty, got admission to the works, saw the first motion of the machinery, and a few minutes after eleven sent off his message to *The Times*, which was published in London before the news was printed in the Buffalo papers. He was much struck with the proposal as to the division of capital, having, in times past, had a good deal to do with the financing of electric companies. He well remembered one company with a very long name, of which he was vice-chairman, which had a capital of a million, the object being to advance money to people who had central station schemes, this being at the time of the boom, just after the electric light exhibition in Paris and at the Crystal Palace. For about a year the board met nearly every week, but their two managing directors who examined the schemes which were sent in, were not able to report favourably of any of them, and at the end of the time the capital was returned to the subscribers. With regard to mortgages on copper in the centre of Africa or Australia, he did not think there was much of a market for it there, but even adding the cost of transportation it might be a good investment.

Mr. G. L. ADDENBROOKE said this was a subject to which he had paid a good deal of attention during

the last few years, but the form in which it was presented almost took one's breath away. He did not wish, however, to say anything derogatory of the view put forward, for which they were much indebted to Professor Forbes. There were no doubt many large sources of water-power in various parts of the world, and in time they might be utilised, but he might point out that for many purposes the cost of electric power was much the same whether generated by steam or water-power. If these great waterfalls were used in this way, it might lead to an enormous shifting of population, and some of the great centres of industry at present might be destroyed. The question was whether there was any danger of this, and whether anything could be done to enable existing manufactories and populations to remain where they were. What Professor Forbes said was perfectly feasible. He thought that Englishmen who had not travelled or specially studied the subject had little notion of what had been done in this way abroad. Nothing struck him more at Geneva and one or two other places than the confidence with which capitalists put immense sums into these water-power transmission schemes, especially considering the difference between them and steam-power installations. In the latter case you could start on a small scale; put down, say, 1,000 horse-power and see if there was likely to be a return; but in the case of water-power it was essential to begin on a large scale. At Rheinfelden they put down a plant and obtained 22,000 horse-power, of which perhaps not more than one-fourth was as yet utilised. But they erected immense works, brought in sidings, built a bridge over the Rhine, bought up all the land in the neighbourhood, and advertised that they would sell sites to manufacturers; so that there was an immense amount of capital locked up which could not be immediately remunerative; but they had sufficient confidence in the thing to wait until it was. What had been done there could no doubt be carried out in other places, such as Professor Forbes had mentioned. The only one with which he had any acquaintance was Western Australia, for while Professor Forbes was considering the scheme to which he had referred, he (Mr. Addenbrooke) was acting for some people who had a concession for lighting Coolgardie, and had to consider what they should do with it, and whether they would not be swamped by power transmitted from the coast. He came to the conclusion that there was not very much risk of it. Having spent some time in the country, he was fairly conversant with the local circumstances, and ascertained from some large shipping people at what price they could land coal at the nearest port. He also found there were coal fields within 500 miles which the Government were developing, and which had since been placed in communication by rail. The railways were in the hands of the Government, who were willing to carry coal at ½d. per ton per mile, and he found that they could get coal delivered in Coolgardie at 45s. a ton or less, and at that price he did not think it would pay to generate power on the coast and transmit it. It would be better to generate it on the spot as they were doing on the Rand, and distributing it up to distances of 20 miles. There the price charged per horse-power was about £45. He mentioned that to show that one of the elements which capitalists would have to consider was the chance of coal being found in the neighbourhood, which might alter the whole of the conditions. At the same time there would be many places where this method of transmitting power would be valuable.

Mr. L. GASTER said that he had visited some institutions in Switzerland, and had seen a steam-engine factory where a current of 5,000 volts was transmitted from a river 12½ miles away with an efficiency of 77 per cent., and it was used for all the purposes of the factory. Some time ago Mr. Wallace read a paper at the Society of Chemical Industry on the utilisation of water-power, in which he said that by that means power could be supplied at a profit for £4 per annum per horse-power, which was cheaper than steam. The one requisite was to have a very large central station, as in that way it was produced more economically. For long distances the way to reduce the charge for copper was to increase the voltage. From Laufen to Frankfort, a distance of 108 miles, a high voltage transmission (although double transformation was used) gave an efficiency at Frankfort of 73 per cent. Large works always produced power more cheaply than small ones, and small manufacturers did better by obtaining their power from such sources than by working independently. Professor Forbes had shown that long distances were no obstacle, and there was every reason to believe that the time was not far off when this method would be very largely adopted. If England had no great amount of water-power she had cheap coal, and if large central stations were established near the coal pits it would be a great benefit to the people at large.

Mr. W. M. MORDEY emphasised the very great technical advances of recent years, which justified the reader of the paper in treating these bold engineering proposals entirely from the commercial standpoint. What will it cost to transmit the power? And what can be got for it? The Chairman had given them two propositions. He ventured to give them a third: If you can make the mouths of capitalists water by showing how to make big profits, you produce a water-power of the greatest value. He congratulated Professor Forbes on having done much to start that power.

Professor FORBES said he had very little to reply to; and perhaps what he had put forward would be like seed sown in the ground, which in due time might yield a valuable return. He did not think the objections raised were really very serious, not even what the Chairman had been good enough to point out, for all the places referred to were not in Central Africa. That question had been fully discussed by himself and

the business men before whom he had put the proposition. It was perfectly obvious that something must be laid by for the removal of the copper, and there were many other points which he might have mentioned ; for instance, it would be essential that those who held the bonds should have some representative on the spot to see how much copper was put down, and that the value remained, and many other precautions would have to be taken, but these were matters of detail, with which he did not think it necessary to burden the paper. He trusted the view put forward by Mr. Mordey would be generally adopted, that they really had no differences to settle in this matter ; at any rate, none worth talking about. The estimates which could be made were like those for building a bridge or any other work ; it was purely a question for business men whether it was worth venturing. He thought the scheme of dividing the capital into a speculative and a solid investment was a sound proposition. He should be glad to be able to get 4 per cent. on such a safe investment as this seemed to him to be, and, as for the speculative side, he thought 40 per cent. ought to make even a large capitalist's mouth water.

The CHAIRMAN then proposed a cordial vote of thanks to Professor Forbes, which was carried unanimously.

Miscellaneous.

EXHIBITION OF LITHOGRAPHS.

Several exhibitions have been held abroad in honour of the centenary of the invention of lithography, more particularly those at Paris, New York, and Düsseldorf; but we have the inventor's own authority for the fact that the real art of lithography, as subsequently practised (or chemical printing, as he himself called it), was not invented until 1798. The invention of 1796 was something quite different. On the frontispiece to the German edition of the inventor's Complete Course of Lithography—*Lehrbuch der Steindruckerey*, 1818, appears the following :—" Der Steindruck erfunden zu München von Aloys Senefelder, 1796, Durch ihn zur chemischen Druckerey erhoben, 1798." This book is now exhibited at South Kensington.

The Society of Arts proposed to organise an Exhibition of Artistic Lithography in the present year, but the Council, finding that they could not provide sufficient space in the Society's rooms, asked the Department of Science and Art to carry out the scheme at the South Kensington Museum. The Lords of the Committee of Council on Education having given their sanction to this, a Loan Exhibition has been formed, which was opened to the public on Monday last. The Exhibition consists of over 2,250 articles, and presents a larger number of artistic lithographs (both historical and modern) than has ever been publicly shown before.

The practice of lithography appears to have been introduced into England almost immediately after its invention, and some specimens of the work of Richard Corbould, Richard Cooper, William Delamotte, and R. L. West, were published by the Polyautographic Society in 1802.

The gold medal of the Society of Arts was not awarded to Senefelder until 1819, or the year after the publication of his work on Lithography. In this same year a silver medal was awarded to C. Hullmandel for a lithographic drawing, and the silver Isis medal to D. Redman for a lithographic drawing on English stone.

The Exhibition at South Kensington shows very clearly the vast capabilities of the art, and the beautiful pictures which have been produced both by artists in the past, and during the remarkable revival of the last twenty years. An exhibition such as this, which is thoroughly international in its scope, cannot but have a considerable effect upon public opinion. Hitherto these fine works have only been known to the few, now the public are enabled to see what has been done in the past and what is being done in the present by artists who know what a matchless medium lithography is for the reproduction of their drawings.

A very large number of the fine old historical lithographs are contributed from the National Art Library, and the possessors of other collections have come forward willingly to help in the formation of a really representative exhibition. In the division apportioned to the English school are early lithographs, published by the Polyautographic Society, of 9, Buckingham-place, Fitzroy-square, previously referred to, Rowney and Forster's Lithographic Press, Rathbone-place, and Ackermann's Lithographic Press, 412, Strand. Fine examples of the work of Samuel Prout, J. S. Prout, Joseph Nash, J. D. Harding, Richard James Lane, Frederick Tayler, Thomas Barker, of Bath, George Scharf, F. W. Hulme, John Linnell, jun., and C. J. Hullmandel are shown. There is a large amount of Louis Haghe's work, some of it reproductions of David Roberts's drawings. Here is Thomas Bewick's only attempt at lithography (Man on Horseback in Rain, 1823, No. 250), and a design of Alfred Stevens, lithographed by himself. Of living artists of the older school, Mr. William Simpson, Mr. John A. Vinter, and others may be noted.

The new school of lithographic artists, headed by Mr. Whistler, are well represented. The names of Messrs. Abbey, Oliver Hall, Legros, McCulloch, Pennell, Rothenstein, Shannon, F. Short, and T. R. Way may be specially mentioned.

A collection of over 800 lithographs of the artists of France are shown, and among these works of of Charlet, Daumiêr, Decamps, Delacroix, Gavarni, Gericault, Isabey, Laurens, Raffet, the two Vernets, and M. Fantin-Latour figure prominently.

Germany contributes 153 lithographs, and the works by Piloty and Menzel are conspicuous in this collection.

The United States, Holland, Belgium, Switzerland, Italy, Russia, and Spain are all represented in the Exhibition. Amongst the specimens from the latter country are three very fine lithographs by Goya, lent by Mr. Philip Norman. One of the curiosities of the Exhibition is a portrait of the Queen, by C. Fuhr ($73 \times 46\frac{1}{2}$) which is said to have been printed from the largest stone ever used.

With the increased use of lithography it may, in the future, become a question whether the supply of Solenhofen stone is likely to fail. Other materials have been tried, and attempts have been made to find a stone which might be used as a substitute for the original stone. T. Barker tried Bath stone; a Spanish stone from the quarries of Salsadella also has been used with success. Senefelder himself said that English, French, and Italian stones had been found serviceable. The Society of Arts offered many years ago a gold medal for the best specimen of lithography "executed on stone, the produce of the United Kingdom or its colonies," and as above mentioned the medal was awarded to D. Redman in 1819.

Zinc plates have been largely used, but principally for commercial purposes, and at the present time experiments are being made in the use of aluminium with fairly good results, as may be seen in the present Exhibition.

Obituary.

Sir John Fowler, Bart., K.C.M.G.—Sir John Fowler, the distinguished civil engineer, who died on Sunday, 20th inst., was a member of the Society of Arts of fifty years standing, having been elected in 1848. He was born in 1817, at Wadsley-hall, Sheffield, and at the age of 17 became a pupil of Mr. J. T. Leather, hydraulic engineer, and was associated with many of the engineering schemes which were at that time carried out for the water supply of Yorkshire and the surrounding districts. When only 26 years of age, he was engineer, manager, and locomotive superintendent of the Stockton and Hartlepool Railway. Amongst the principal works executed by Sir John Fowler were the original "Underground" or Metropolitan Railway, the District Railway, the St. John's-wood Railway, the Victoria Station and Pimlico Railway, on which occurred the first railway bridge built over the river Thames at London, and many other railway works all over the country. He was consulting engineer to several of the great railway companies, and also to the Government of Egypt. In 1888, he was made a K.C.M.G. in recognition of important service rendered in connection with the Soudan campaign. On the completion of that great work—the building of the Forth Bridge, which he carried out in conjunction with Sir Benjamin Baker—he was created a baronet. Sir John Fowler was President of the Institution of Civil Engineers in 1866, and received the honorary degree of LL.D. from the University of Edinburgh in 1890.

Sir Stuart Knill, Bart.—The death of Alderman Sir Stuart Knill occurred at Blackheath on 19th inst., after an illness of about a month's duration. Sir Stuart was elected a member of the Society of Arts in 1861, and he filled the office of Vice-President from 1893 to 1896, during which time he was a constant attendant at the Council and at the evening meetings. He was born in 1824, and succeeded his father as head of the firm of Messrs. John Knill and Co., wharfingers and warehouse keepers. It was not until 1885 that he became officially connected with the Corporation of London. He was then elected Alderman of the Ward of Bridge Within in succession to Sir Charles Whetham. He served the office of Sheriff in 1889, and was elected Lord Mayor in 1892. He was created a baronet in celebration of the marriage of the Duke and Duchess of York. In 1897, Sir Stuart accepted the sinecure aldermanry of the Ward of Bridge Without, and he had the satisfaction of seeing his son, Mr. John Knill (his successor in the baronetcy) succeed him as Alderman of Bridge Within.

General Notes.

Provincial Exhibition at Ghent.—The Provincial Exhibition of East Flanders, which is to be held at Ghent during the summer of 1899, will, says the United States Consul there, be opened on June 14th. While the principal exhibits will naturally be made by residents of the province there will be a department for foreign exhibitors. There will be exhibits in fine arts, industrial arts, hygienic life-saving apparatus, instruction and science, literature (Flemish and French), woman's work, alimentation, horticulture, agriculture, apiculture, lighting, heating and ventilating apparatus, sporting goods, arts, export trade and colonial products. Inquiries with reference to this Exhibition are to be addressed to the executive committee, 47, Boulevard Leopold, Ghent.

The Ivory Trade.—The greater part of the ivory imported into Europe comes from different regions of Africa; British India and Ceylon furnish a comparatively small quantity. Africa, according to the *Moniteur Officiel du Commerce*, contributes about 1,764,000 pounds of ivory annually distributed among the different centres of exportation as follows:—From Zanzibar, 441,000 pounds; Mozambique,

220,000; Gaboon, Cameroons, Lagos, 165,000; Niger Territories, 166,000; Loanda, Benguela, 221,000; Cape Colony, 110,000; Egypt, 331,000; and the Red Sea Coast, 110,000 pounds. The principal markets for ivory are London, Liverpool, and Antwerp. Hamburg also carries on an important trade, but a great part of it has first passed through the London market. Of the work imported at Antwerp, the larger part is from the Congo Free State. As regards the uses to which ivory is put, France, England, Germany, and the United States manufacture the four principal articles in ivory, viz., billiard balls, piano keys, comb and knife handles; in addition France makes a specialty of brushes, fancy articles, handles of umbrellas, and carved goods. Spain manufactures a considerable quantity of billiard balls; Italy and Turkey, combs; Austria, billiard balls and keys; Holland, a very few balls, and Belgium some fancy and carved goods.

COACHBUILDING.—The Company of Coach Makers and Coach-Harness Makers of London offer the following prizes for competition among British subjects generally, resident in the United Kingdom of Great Britain or Ireland:—Competition No. 1—Prizes are offered to competitors, under the age of 22 years, for sets of three drawings of (1) a square sociable, (2) a victoria (both vehicles on elliptic springs), and (3) a lady's pony vehicle (any pattern) hung on two wheels; scale, one inch to the foot; 1st prize, £3; 2nd, £2; 3rd, £1. No. 2—Prizes are offered to competitors, under the age of 25 years, for perspective designs of a lady's pony vehicle of any description; scale, one inch to the foot; 1st prize, £3; 2nd, £2; 3rd, £1. No. 3—Prizes are offered to competitors, under the age of 21 years, for working drawings of an elegant cab-body one-horse victoria, on elliptic springs, side elevation, half back and half plan and looking from the bottom; scale, two inches to the foot; 1st prize, £3; 2nd, £2; 3rd, £1. No. 4—Prizes are offered to competitors, under the age of 35 years, for perspective drawings of a skeleton double cab-shaped sociable on elliptic springs, with driving seat supported on elegant open iron-work; hood down, with dotted lines shewing it up; drawings to be tinted or shaded in grey colour; scale, six inches to the foot, on one piece of paper, 8 feet by 4 feet; 1st prize, the Company's silver medal and £6; 2nd, the Company's bronze medal and £4; 3rd, the Company's certificate and £2. No. 5—Mr. George Edwards (the master of the Company) offers £10 10s., to be divided as follows among competitors, under the age of 30 years, for essays on road carriage axles of all sorts, including ball-bearing axles, their manufacture, uses, advantages and disadvantages, and suitability for use in all parts of the world; 1st prize, £6 6s.; 2nd, £4 4s. No. 6—For a short descriptive statement and working drawings of a public conveyance to carry passengers for excursions or pic-nic parties. Particular and special attention to be given to the construction of the vehicle to ensure safety and avoid upsetting; scale of drawings, two inches to the foot; prize, £10. The above prizes will be accompanied by the certificate of the Company. The prize winner in any of the competitions showing the greatest merit, if not already free of the Company, may have the Honorary Freedom conferred upon him should his drawing or essay in the opinion of the judges deserve it. Drawings and essays to be delivered free at the hall of the Company, Noble-street, St. Martin's-le-Grand, London, on or before April 10, 1899.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

NOVEMBER 30.—"Photographic Developers and Development." By C. H. BOTHAMLEY, F.C.S. COL. J. WATERHOUSE, Hon. Sec., Royal Photographic Society, will preside.

DECEMBER 7.—"Egypt and the Soudan, in 1897 and 1898." By W. T. MAUD, Artist and Correspondent to *The Graphic*.

DECEMBER 14.—"Commercial Education." By SIR ALBERT ROLLIT, LL.D., M.P.

Papers for meetings after Christmas:—

"Tuberculosis in Animals." By W. HUNTING.

"Canals and Inland Navigation in the United Kingdom." By L. F. VERNON-HARCOURT, M.A.

"Preservation of Timber." By S. B. BOULTON.

"Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

"Leadless Glazes." By WILTON P. RIX.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at 4.30 o'clock:—

January 19, February 9, March 9, April 13, May 11, 25.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at 4.30 o'clock:—

December 6, January 24, February 28, April 25.

At the meeting before Christmas the following paper will be read:—

TUESDAY, DECEMBER 6.—"The Yangtse Basin and the British Sphere." By ARCHIBALD LITTLE, F.R.G.S., of Chungking. The Right Hon. SIR RICHARD TEMPLE, Bart., G.C.S.I., C.I.E., will preside.

*** Numerous lantern slides of the Upper Yangtse and beyond will be shown and described by Mrs. LITTLE.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings at 8 o'clock :—

January 31, February 21, March 14, April 18, May 2, 30.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at 8 o'clock :—

PROF. VIVIAN B. LEWES, "Acetylene." Four Lectures.

LECTURE II.—NOVEMBER 28.

The commercial production of acetylene—Calcic carbide and its properties—The electric furnace and the various modifications in use for carbide manufacture—Carbide without electrical power—Carriage and storage of carbide.

LECTURE III.—DECEMBER 5.

The commercial generation of acetylene—The types of generator in use—The actions taking place in acetylene generators, and the effect upon the gas produced—The purification of acetylene for domestic consumption.

LECTURE IV.—DECEMBER 12.

The combustion of acetylene—Acetylene burners—Smoking and carbonising of burners—Burners for heating—Acetylene for gas engines—Diluted Acetylene and its applications.

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

January 16, 23, 30, February 6.

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

February 20, 27, March 6, 13.

PROF. HENRY R. PROCTER, "Leather Manufacture." Four Lectures.

April 10, 17, 24, May 1.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, the 4th and 11th of January, at Seven p.m.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian Lewes, "Acetylene." (Lecture II.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Mr. Gilbert Thomson, "A Suggested Standard for Drain Testing."

Imperial Institute, South Kensington, 8½ p.m. Mr. Ernest Lidgey, "Gold-mining in Victoria."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Sir Wyke Bayliss, "Art—Contra the World, the Flesh, and the Devil."

TUESDAY, Nov. 29...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Stanley Robert Kay, "The Effect of Subsidence due to Coal-Workings upon Bridges and other Structures."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. E. A. Goeldi, "Further Notes on the Amazonian Lepidosiren." 2. Mr. F. G. Parsons, "The Anatomy of Adult and Fœtal Specimens of *Pedetes caffer* as compared with that of the *Dipodidæ*." 3. Mr. F. O. Pickard-Cambridge, "New Species of Spiders from Trinidad, West Indies."

WEDNESDAY, Nov. 30...SOCIETY of ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. C. H. Bothamley, "Photographic Developers and Development."

British Astronomical, Sion College, Victoria-embankment, W.C., 5 p.m.

Royal, Burlington-house, W., 4 p.m. Annual Meeting.

THURSDAY, DEC. 1 . Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. R. H. Biffen, "The Biology of *Agaricus velutipes*, Curt." 2. Mr. Jas. Johnstone, "The Gastric Glands of the *Marsupialia*."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. H. J. H. Fenton and H. Jackson, "The Oxidation of Polyhydric Alcohols in Presence of Iron." 2. Ballot for the Election of Fellows.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Eric T. Bruce, "Some Experiments in Persistance of Vision."

FRIDAY, DEC 2...Royal Institution, Abemarle-street, W., 9 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. Charles Benjamin Saner, "The Sunlight Gold-bearing Reef, Lydenburg, Transvaal."

Geologists' Association, University College, W.C. 8 p.m. Mr. A. M. Davies, "Contributions to the Geology of the Thame Valley."

Quekett Microscopical Club, 20, Hanover-square W.C., 8 p.m.

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FRIDAY, DECEMBER 2, 1898.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, 1899, at 7 o'clock, by Professor F. JEFFREY BELL, M.A. (of the Department of Zoology, British Museum). The first lecture will be on "Hands and Feet," and the second lecture on "Some Ways in which Animals Breathe." The lectures will be fully illustrated with lantern slides.

Due notice will be given when the tickets for the lectures are ready for issue.

A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received. Subject to these conditions each member is entitled to a ticket admitting two children and an adult.

CANTOR LECTURES.

Professor VIVIAN B. LEWES delivered the second lecture of his course on "Acetylene," on Monday evening, 28th ult. The lectures will be published in the *Journal* during the Christmas recess.

APPLIED ART SECTION.

A meeting of the Committee of the Applied Art Section was held on Wednesday afternoon, 30th November. Present :—Sir George Birdwood, K.C.I.E., C.S.I. (chairman); C. Purdon Clarke, C.I.E., Alan S. Cole, I. Hunter Donaldson, J. Starkie Gardner, W. Gowland, Sir Villiers Lister, K.C.M.G., T. Buxton Morrish, J. Hungerford Pollen, Sir Walter S. Prideaux, J. Sparkes, and Sir Thomas Wardle, with Sir Henry Trueman Wood, Secretary to the Society, and Henry B. Wheatley, Secretary to the Section. The arrangements for the new Session were considered.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, November 30, 1898; Colonel J. WATERHOUSE, Hon. Secretary of the Royal Photographic Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Agnew, Sir William, Bart., 11, Great Stanhope-street, W.
Gardiner, Henry Nathaniel, 30, Finsbury-circus, E.C
Gibb, George S., North Eastern Railway, York.
Hayles, George Edward, 12, Northampton-park, Canonbury, N.
Jacob, Augustus Hamilton, M.A., 26, Maberley-road, Upper Norwood, S.E.
Rayner, Arthur B., 56, Paddington-street, W., and 68, Oakfield-road, Finsbury-park, N.
Sears, Arthur Holroyd, Cae Glas, Llandrindod Wells Radnorshire.
Townsend, John Walter, Wendreda, Lancaster-road, Wimbledon, S.W.
Walker, Arthur Tannett, Messrs. Tannett, Walker and Co., Leeds.

The following candidates were balloted for and duly elected members of the Society :—

Acland, Sir C. Thomas Dyke, Bart., Killerton, Devon.
Annear, Joseph Henry, Morwell-cottage, West-street, Harwich.
Bannerman, William Bruce, The Lindens, Sydenham-road, Croydon.
Bhumgara, Jamsetjee S., 135, London-wall, E.C., and 8, Loudoun-road, N.W.
Boult, Wilfrid Swanwick, Sudbury, Beechcroft-road, Upper Tooting, S.W.
Boyd, William Christopher, The Grange, Waltham-cross, Herts.
Brickwood, John, Ortageny, Southsea, Hants.
Brown, Alfred Charles, Eastern Telegraph Company, Winchester-house, Old Broad-street, E.C., and 129, Algernon-road, Lewisham, S.E.
Burrell, Arthur William, M.D., 5, Baker-street, W.
Byrne, Rev. Father, Catholic Presbytery, Court-road, Barry Dock, Glamorganshire.
Carey, Alfred Edward, 39, Trinity-sq., Tower-hill, E.C.
Cawson, James, 8, Alfred-place, Bedford-square, W.C.
Cheesley, Robert Godwin, 16, Canonbury-street, N.
Corner, Walter William, 115, Fellows-road, South Hampstead, N.W., and City Liberal Club, Walbrook, E.C.
Coventry, Henry G., Worsley, near Manchester.
Coventry, Walter Bulkeley, Burgate-house, Fordingbridge, Salisbury.
DeBrath, Stanley, Grande Roque, Guernsey.
Dodds, John Bradburne, Stotes hall, Jesmond, Newcastle-on-Tyne.
Duncan, Harold M., Hyde-park-court, Albert-gate, S.W.
Duncanson, Edward Ford, Nutwood, Bickley, Kent.

Edgcumbe, Kenelm, 33, Tedworth-square, S.W.
Elworthy, Thomas, London-road, St. Leonard's-on-Sea.
Erskine, Captain William Charles Chitty, New Club, Princes-street, Edinburgh.
Finny, Commander T. G. R., R.I.M., Royal Bombay Yacht Club-chambers, Bombay.
Gadsby, Charles Herbert, Donington-house, Norfolk-street, Strand, W.C.
Gibb, Alexander, 23, Chapter-road, Willesden-green, N.W.
Gibson, William Augustus, 4, Queen Victoria-street, E.C.
Girtin, George Wyndham Hog, 125A, Highbury New-park, N.
Gordon, William Gordon, Knowlesly, Port of Spain, Trinidad.
Gould, Henry, 1, Matthew's-lane, Kingston, Jamaica.
Hamong, Count de, 180, New Bond-street, W.
Harding, Josiah, 51, Hill-lane, Southampton.
Hay, Walter Robert, 20, Abchurch-lane, E.C.
Holah, Ernest, 5, Crown-court, Cheapside, E.C., and Sun Trap, Radcliffe-road, Croydon.
Howard, Henry Lionel, 38, St. George's-road, S.W.
Humphreys, Henry Howard, 6, Stanley-gardens, Willesden-green, N.W.
Jones, Walter Lindley, 21, St. Helen's-place, E.C.
Kimmins, C. W., M.A., D.Sc., Bermondsey Settlement-lodge, Farncombe street, S.E.
Langdon, William, Oakfields, Kingsbury, N.W.
Lugard, Cecil Edward, 97, Sinclair-road, West Kensington, W.
Mackenzie, Sir Alexander, K.C.S.I., 71, Lancaster-gate, W.
Mair, George John, Millom, Cumberland.
Marshall, Charles H., The Poplars, Howard-street, York.
May, Cornelius, Oxford-street, Freetown, Sierra Leone.
O'Dwyer, Arthur Williamson, Duketown, Old Calabar, Niger Coast Protectorate, West Africa.
Ormerod, John, 62, Chorley New-road, Bolton.
Osman, Constant Edward, 132, Commercial-street, E.
Oulton, William, J.P. (Lord Mayor of Liverpool), Hillside, Gateacre, Liverpool.
Park, C. J., 23, Mutley-plain, Plymouth.
Parkinson, John, 251, Camden-road, N.
Pentheny-O'Kelly, Captain Edmund de, Sierra Leone, West Africa, and Badminton Club, 100, Piccadilly, W.
Pickering, Robert Young, Railway Wagon Works, Wishaw, N.B.
Plant, Edmund H. T., Charters Towers, North Queensland.
Reed, Frederick Richard Cowper, M.A., The Limes, Oxford-road, Cambridge.
Rollin, Charles, B.Sc., 1, Queen's-road, Jesmond, Newcastle-on-Tyne.
Ross, Alexander, Great Northern Railway, King's-cross Station, N.
Rundell, T. W., 25, Castle-street, Liverpool.
Sam, Thomas Birch Freeman, Cape Coast Castle, West Africa.
Sayer, Harry, 10, Nottingham-terrace, N.W.
Schattner, Ernest B., 78, Mill Hill-road, Norwich.
Scott, Sir John, K.C.M.G., M.A., Malabar-house, St. Albans, and 1, Adam-street, Adelphi, W.C.
Sheer, John, 13, King's College-road, South Hampstead, N.W.
Skilbeck, George Thornton, Clonard, Harrow Weald, Middlesex.
Stevens, Charles Cecil, C.S.I., Fair View, Church-hill, Honiton.
Swan, Edward Arthur, 74, Culverden-park-road, Tunbridge Wells.
Vaughan, John C., Wraxall, near Bristol.
Ware, Captain F. Webb, I.C.S., Quetta, Baluchistan, India.
Wilson, Norman James, 70, Waterloo-road, N., Wolverhampton.
Woollan, Benjamin Minors, Fairfield-lodge, 6, Addison-road, W.

The paper read was—

PHOTOGRAPHIC DEVELOPERS AND DEVELOPMENT.

By C. H. Bothamley, F.I.C., F.C.S.

Photographic developers are many, and the phenomena of development are complex and often obscure. It is impossible in the time at my disposal to deal with more than a comparatively small part of such a wide subject, and I propose, therefore, to consider developers rather than the operation of development, though the latter must naturally be dealt with incidentally.

It is a noteworthy fact that with the exception of ferrous oxalate and ferrous citro-oxalate all the substances that have been found to be of any practical value as developers for gelatinobromide plates, are carbon compounds, and with one exception are derivatives, and comparatively simple derivatives, of one and the same parent substance, the hydrocarbon benzene.

For some time pyrogallic acid or pyrogallol, which had been used as a developer in the collodion process, was the only carbon compound applied as a developer for gelatino-bromide plates. In 1880, however, Captain Abney, to whom photography owes so much, showed that hydroquinone or, to use its systematic name, quinol, not only may be used as a developer but has properties that distinguish it from pyrogallol and make it especially useful for particular purposes. In the same year Eder and Toth recognised that pyrocatechin,

or, again to be systematic, catechol, which is very closely related, and in many ways very similar to quinol, likewise has strongly marked developing power. Up to the present time, however, this compound has been but little used, partly because until quite recently it has been comparatively costly. Some years later an α-amido-β-naphthol-β-sulphonic acid, which was described by Meldola in 1881, was recognised by Dr. Andresen as a photographic developer of considerable power, and its sodium salt was placed on the market under the trade name of eikonogen. For a time it was distinctly popular, but it is doubtful whether it is used to any large extent now, not because of any special demerits, but because photography, and especially amateur photography, is peculiarly subject to fashions, and for a time at least eikonogen seems to have been displaced by later novelties, such as paramidophenol, amidol, and metol.

Since 1890 new developers have appeared in even greater numbers than minor planets, and to-day there are at least twelve distinct developing agents in the market: pyrogallol, catechol, quinol, eikonogen, metol, paramidophenol, amidol, glycin, ortol, diamidoresorcin, diphenal, and diogen. Perhaps to these may be added reducin, and if we were to include all the substances that have been patented as developers, the total number would not fall far short of a hundred. This embarrassment of riches, for such the average photographer finds it to be, is mainly due to two German chemists, Dr. J. Hauff, of Feuerbach, and Dr. M. Andresen, of Berlin, who have inquired into the developing properties of a very large number of benzene and naphthalene derivatives. Their investigations have not only resulted in a number of patents, but what is very much more important, have paved the way for the recognition of certain relations between the constitution of benzene derivatives and their power of acting as photographic developers. The establishment of these relations is valuable, not only because they reduce chaos to at least a semblance of order, but also because they indicate the directions in which further investigations may be made with the greatest promise of useful results.

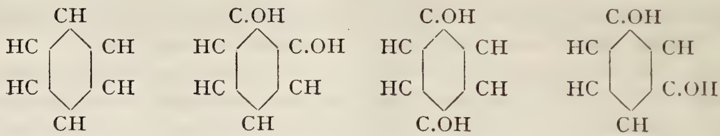
The broad general principles were first definitely enunciated independently by Dr. Andresen and by Messieurs A. and L. Lumière, of Lyons, in July, 1891, and a summary of the position to which they have brought the matter will probably be of interest, premising at the outset that in some points of detail they are not quite in agreement even as to matters of fact.

All the benzene derivatives that are known to act as photographic developers, with one or two partial exceptions, to be referred to hereafter, contain hydroxyl groups (OH) or amido groups (NH_2) that have been substituted for hydrogen, and moreover contain at least two such groups, which may be either both hydroxyls, or both amido groups or one hydroxyl and one amido group. Phenol and aniline and their homologues are not developers.

Chemists are familiar with the fact that the bisubstitution derivatives of benzene, in which two out of the six atoms of hydrogen originally in the hydrocarbon have been displaced by either elementary or compound radicles, are capable of existing in three distinct modifications or isomerides, which have the same composition, but differ from one another in physical properties, such as crystalline form, melting point, and solubility, and also in chemical behaviour, more especially as regards their aptitude to enter into chemical reactions, the character of the reactions in which they will take part, and the nature of the products that they yield under similar conditions, and notably when treated with oxidising agents. The three modifications are known respectively as the ortho-derivatives, para-derivatives, and meta-derivatives, and the differences between are believed to be due to differences in the arrangement of the atoms within the molecule, and in particular to the relative positions of of the elements or groups that have been substituted for hydrogen. Adopting the usual plan of representing benzene by means of a hexagon with a carbon atom and a hydrogen atom at each of the six angles, the three dihydroxy derivatives of benzene, in which two hydrogen atoms have been displaced by two hydrogen groups (OH), are represented by the formulæ on page 44.

A similar plan is adopted for all other bisubstitution derivatives. In the ortho-derivatives the two substituted radicles are supposed to be adjacent; in the para-derivatives they are directly opposite; in the meta-derivatives they are neither adjacent nor directly opposite, or, in other words, they cannot be represented as lying at the opposite extremities of any side or diagonal of the hexagon.

Now it is found that whilst the ortho and para-derivatives are developers, the meta-derivative has no developing power. Ortho-dihydroxybenzene is catechol, or pyrocatechin, to which reference has already been made,



Benzene Ortho- Para- Meta-

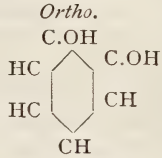
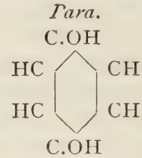
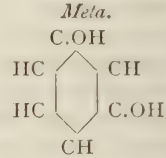
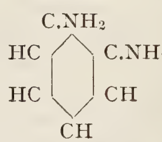
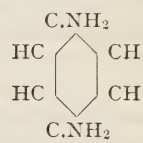
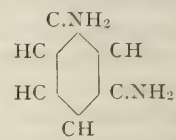
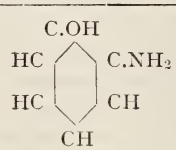
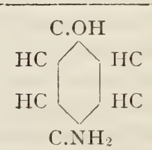
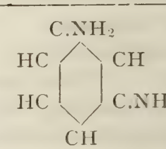
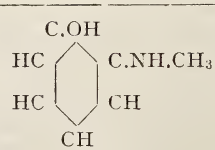
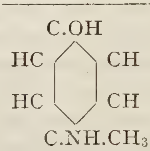
dihydroxybenzene.

whilst paradihydroxybenzene is quinol, or hydroquinone, which is well known and widely used as a developer.

The metadihydroxybenzene is also well known under the name of resorcin, or resorcinol, and is of great practical importance from other points of view, but it has no power of developing the latent image on an exposed gelatino-bromide plate.

Similarly, the ortho and paradiamidobenzines (phenylene diamines), have developing power, but metadiamidobenzene (metaphenylene diamine) has none or exremely little.

The same law holds good when the amido-group and the hydroxyl group occur together; orthoamidophenol and paramidophenol are developers, but metamidophenol is not. One of these, paramidophenol, is now tolerably well known, and is sufficiently in vogue as a developer to be included amongst those put up by Burroughs and Welcome in the convenient form of tabloids; it is also the active constituent of the developing solution sold as "Rodinal." The constitution of these three groups is shown in the following Table:—

	Developers.		Non-developers.
	Ortho.	*Para.*	*Meta.*
Dihydroxy-benzenes	 *Catechol.*	 *Quinol.*	 *Resorcinol.*
Diamido-benzenes .... *(Phenylene diamines)*			
Amido-hydroxy-benzenes.... *(Amidophenols)*		 *Paramidophenol*	
Methamido-hydroxy-benzenes	 *Ortol.*	 *Metol (Andresen).*	

In the case of derivatives of diphenyl,

$C_6H_5, C_6H_5,$

which is formed by the union of two benzene nuclei, the two amido or hydroxyl groups must be in the same benzene nucleus.

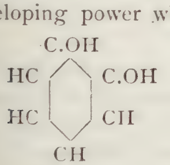
Benzidine, or diamidodiphenyl, $NH_2C_6H_4.C_6H_4NH_2$, is not a developer because the two amido groups are in different benzene nuclei, but hydroxydiamido-diphenyl,

$NH_2.C_6H_4.C_6H_3(OH)(NH_2),$

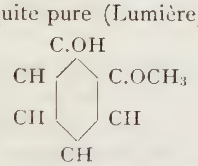
is a developer, because one amido group and one hydroxyl group are associated in the same benzene nucleus in the para-position. Hydroxydiamidodiphenyl is the active constituent of the developer diphenal.

Naphthalene derivatives, to be developers, must also contain at least two hydroxyl groups, or two amido groups, or one hydroxyl and one amido group, but it would seem that in this case the two groups need not both be in the same benzene nucleus, and it is not quite definitely ascertained whether the rule with regard to meta-derivatives holds good. The association of two benzene nuclei to form a naphthalene molecule is of a very intimate character, different from that which obtains in the case of diphenyl, and the various derivatives show certain relations and differences that are not observed in the case of benzene derivatives. As illustrations of the main general law however, it may be stated that the naphthols and the naphthylamines are not developers, but most of the dihydroxynapthalenes and the amidonaphthols are developers in a greater or less degree.

Returning to the benzene derivatives, it is well-known that the hydrogen of the hydroxyl group, or the amido group, can be displaced by alkyl radicles such as *methyl* CH_3 or *ethyl* C_2H_5, and also by other radicles, and the results are of some practical importance. In the case of a developing compound that contains two hydroxyl groups or one hydroxyl and one amido group, the substitution of a radicle for the hydrogen of an hydroxyl group destroys the developing power; for example, methylcatechol, commonly known as guaiacol, has no developing power when quite pure (Lumière).



Catechol.

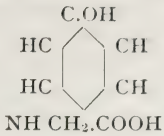


Methyl-catechol.

On the other hand, when a similar substitution takes place in the amido group the results are quite different, and some of the products are already important developers.

Methylorthoamidophenol is the chief constituent of the valuable developer "ortol;" whilst methylparamidophenol is Andresen's "metol," and its homologue, methylparamidometacresol, is Hauff's metol. The constitution of the first two compounds is shown in the Table already given. Both "metols" act practically in the same way, and this seems to be true also of the parent substances, paramidophenol and paramidocresol, so far as the behaviour of the latter has been examined.

The chief advantages gained by the introduction of an alkyl group in place of the hydrogen in the amido group are increased solubility in water and a slight increase in developing power. An apparent exception to the latter statement, however, is "glycin,"



Glycin.

which is parahydroxyphenylglycin, or is paramidophenol, in which one of the hydrogen atoms of the amido group has been displaced by the group $CH_2.COOH$. It is, however, more properly regarded as glycin, $NH_2.CH_2.COOH$, in which an atom of hydrogen has been displaced by the hydroxyphenyl group, $C_6H_4.OH$.

It may be convenient to state here the broad general distinction between developers which owe their power to hydroxyl groups and those which owe it to amido groups. Dr. Eder has pointed out that all the developers in use may be broadly divided into two groups, according to the manner of their action on those parts of the sensitive film that have received different exposures. The members of the first group develop the image gradually and step by step, the high lights of the subject first making their appearance, and being followed by the other parts of the image in the order of their relative brightness. The members of the second group act differently; all the details of the image appear almost simultaneously, whether they represent dark parts or bright parts of the object, and afterwards the various parts gradually acquire opacities that represent their relative brightness. In the first group Eder places pyrogallol, catechol, and quinol; and in the second group amidol, eikonogen, metol, and paramidophenol. The first group contains developers that are suitable for normal exposures and over-exposures; the second contains those that are suitable for normal exposures or under-exposures, such as are frequently given in hand-camera work. It is clear that with one and the same exposure the two groups of developers would give negatives of very different characters, especially if development were not pushed to its limit; and this is well shown by the example thrown on the screen. One half of the plate was developed with pyro-soda, and the other half with metol-soda, and it is evident that the

gradations of the two halves are markedly different.

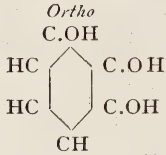
The fact to which I wish especially to draw attention, is that all the members of Eder's first group owe their developing power to hydroxyl groups only; whereas those in the second group contain both amido and hydroxyl groups. It is a noteworthy fact that no developer containing amido groups without a hydroxyl group has yet been adopted for practical purposes. Other compounds, such as orthomethylamidophenol may be added to Eder's second group, and it would seem that we must attribute to the amido group the peculiar property of developing and making visible those parts of the image where the action of light has been smallest, with practically the same rapidity as those parts where the action of light has been greatest. This view is supported by the fact that this peculiarity is more marked when more than one amido group is present. In any case there can be no doubt that the property of developing in this way makes the group of developers especially valuable when dealing with subjects that have great extremes of light and shade, particularly where circumstances are such that only a minimum exposure has been or can be given.

It is, however, necessary to point out that there is no hard and fast line between the two groups of developers, and even the mode of action of one and the same developer depends on the manner in which it is used.

With the tri-substitution derivatives, *i.e.*, those in which three hydrogen atoms of the benzene have been displaced by hydroxyl or amido groups, or partly by one and partly by the other; the same general law holds good. The ortho- and para-derivatives are developers, whilst the meta-derivatives are not. As examples we may take the three trihydroxybenzenes, the ortho-derivative being pyrogallol.

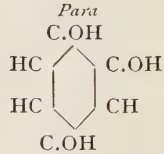
Developers. Not a developer.

Ortho



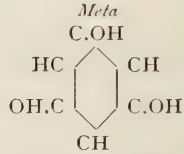
Pyrogallol.

Para



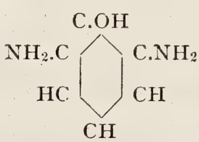
Hydroxyquinol.

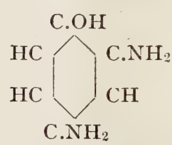
Meta



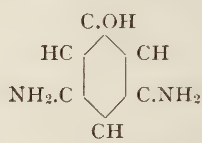
Phloroglucinol.

And also some of the diamidophenols, of which there are six altogether.





Amidol.



In these cases the effects of substitution in the hydroxyl or amido groups themselves are similar to those observied with the bi-substitution derivatives, making due allowance, of course, for the fact that, where three hydroxyl groups are present, displacement of the hydrogen of one of them only will not destroy the developing power if the two that are left are in the ortho or para positions.

Other points concerning the relation between chemical constitution and developing power have received attention, and notably the influence of the carboxyl group COOH and the sulphonic group HSO_3, but at present no very definite conclusions can be drawn, and the results do not seem to be of much practical importance. Generally speaking, it would seem that the introduction of either of these groups into the molecule reduces the developing power of the compound, and in some cases destroys it altogether. Here again the naphthalene derivatives show differences from the benzene derivatives.

Since the developing power of carbon compounds is traceable to the presence of hydroxyl and amido groups, it becomes a question of some interest whether these groups show developing power when they are in one free state as hydrogen peroxide (dihydroxyl HO.OH) and hydrazene (diamide or amidogen $H_2N.NH_2$) unassociated with a benzene nucleus, and this interest extends to hydroxylene $NH_2.OH$, which may be regarded as a compound of both groups.

It was stated a few years ago by Le Roy that hydrogen peroxide in strongly alkaline

solution will develop the latent image on gelatinobromide plates, and that alkali peroxides behave similarly. This statement I am able to confirm, and I show some examples. The developing power of hydrogen peroxide is comparatively feeble, but that of alkali peroxide is much stronger, and it is not greatly inferior in energy to some of the organic developers. The evolution of oxygen that accompanies the reduction, causes the gelatine to swell up in innumerable small blisters. Hydrazine, in presence of an alkali, has also considerable developing power (examples shown), whilst hydroxylamine is still more efficient, and may, in fact rank with the ordinary organic developers. The power of hydroxylamine was recognised in 1884 by Egli and A. Spiller, and probably the only cause that has prevented its general adoption is the fact that the nitrogen liberated in the reaction produces small bubbles or blisters in the gelatine. The same phenomenon is observed in a greater degree with hydrazine.

The developing power of hydrazine and hydroxylamine is found to exist also in derivatives that do not strictly conform to the general laws previously stated. That phenylhydrazine, $C_6H_5.HN.NH_2$, is a somewhat powerful developer was recognised so long ago as 1887, by E. Jacobsen, who also found that its homologues and napthylhydrazine behave in a similar way. Phenylhydrazine has the same composition as phenylene diamine, but in the one case the nitrogen atoms are in direct union with one another, whilst in the other they are not, but are associated with different carbon atoms. In the one case the phenyl group has been substituted for one of the hydrogen atoms in the hydrazine molecule $H_2N.NH_2$, whilst in the other two amido groups have been substituted for two hydrogen atoms of the benzene molecule.

Phenylhydroxylamine $C_6H_5.NH.OH$ and its homologues also have developing power, and it is noteworthy that the relation between phenylhydroxylamine and amidophenol is very similar to that between phenylhydrazine and phenylenediamine.

All photographers are aware that these various developers will not act by themselves, but have to be mixed with an alkali, or in some cases with an alkali sulphite only, in order to bring their developing powers into play. They are potential developers rather than actual developers. Very generally too when an alkali carbonate or hydroxide is used an alkali sulphite is also added, as recommended by Berkley in 1882, mainly for the purpose of preventing the discolouration of the developer and the consequent staining of the film. In view of these facts it is customary to speak of the organic developers as "alkaline developers," but the question at once arises, what do we mean by "alkaline" in this connection? Chemists recognise different degrees of alkalinity, as shown by different indicators, and these different degrees have a different significance. There is alkalinity or acidity to phenolphthalein, and there is alkalinity or acidity to methyl orange, which are by no means the same thing, and there is also alkalinity or acidity to the familar litmus, which is less definite in its significance than the other two. When we speak of alkaline developers, which degree of alkalinity do we mean?

Many years ago Abney showed that pyrogallol will develop an image when simply mixed with an alkali sulphite, and this result has been confirmed, and it has further been shown that the same result is obtained when special care is taken, that the sulphite contains no alkali carbonate. It is then not alkaline to phenolphthalein, but is alkaline to litmus. It has been stated that quinol and catechol do not develop when mixed with a sulphite only, but I find that as a matter of fact development does take place under these conditions, though very slowly, in complete absence of an alkali carbonate or hydroxide. It requires 30 hours at a temperature of about 50° Fahr. to reach a moderate degree of opacity.

Again, pyrogallol will develop an image completely in presence of an alkali bicarbonate, and in these cases also the solutions are alkaline to litmus but are not alkaline to phenolphthalein. Development is naturally slower than with the normal carbonate, but the method can be applied with distinct practical advantages to plates that have been much over-exposed or that show a marked tendency to general fog if treated in the ordinary way.

Further, paramidophenol, methylorthoamidophenol, metol, amidol, and diamidoresorcin, all develop when mixed with an alkali sulphite free from carbonate or hydroxide.

It folows, therefore, that the minimum *active alkalinity*, if I may use the expression, is alkalinity to litmus. It must, however, be understood that with this degree of alkalinity development is usually very slow, too slow in fact to be of practical value except in special cases. Amidol (diamidophenol) diamidoresorcinol, triamidophenol, and probably

other derivatives that contain at least two amido groups with a hydroxyl group are exceptions to the general rule, since they give a workable rate of development when mixed with normal sodium sulphite alone.

As a rule, however, a normal alkali carbonate or an alkali hydroxide must be added; that is to say, the liquid must be made alkaline to phenolphthalein, and, with the exceptions just mentioned, this degree of alkalinity must be regarded as the working alkalinity.

In most cases sodium carbonate or potassium carbonate is the alkali used; sodium and potassium hydroxide have to be employed with great care, and ammonia gives satisfactory results only with pyrogallol, and that only with comparatively few of the various brands of gelatine bromide plates at present on the market. The great drawback to the use of alkali hydroxides (caustic alkalies) is that unless the proportion is kept very low the developer becomes too energetic, and produces general fog, or, in other words, reduces silver bromide that has not been exposed to light instead of attacking only that which has been exposed.

Unfortunately at the present time we are almost entirely without exact information as to the relative effects of sodium and potassium carbonate. It is generally believed that potassium carbonate is the more energetic of the two, and this is probably the case, but so far as I am aware no really careful comparison has ever been made. It may serve as an example of the loose kind of experimenting from which exact photography suffers so much if I point out that in a number of such comparisons as have been made, a given weight of anhydrous potassium carbonate has been compared with the same weight of soda crystals, that is, hydrated sodium carbonate containing very nearly two-thirds of their weight of water. It is scarcely to be wondered at that when compared in this way potassium carbonate was found to be more energetic than sodium carbonate.

There are a few exceptions to the general rule that solutions must be at least alkaline to litmus in order to obtain developing power. In this respect also naphthalene derivatives seem to provide exceptions. Eikonogen when dissolved in water yields a solution that is decidedly acid to litmus, and I find that such a solution will develop image on an exposed plate, although the action is very slow, even when the plate has received many times the normal exposure; a period of about 48 hours being required to obtain a satisfactory opaque image with a 2 per cent. solution of eikonogen. Given sufficient time, however, enough and more than enough opacity can be obtained, and I think development in this way is worthy the attention of anyone who has to develop plates that in ordinary phraseology are known to be "hopelessly over-exposed." It was recognised some years ago that eikonogen will develop very fairly well with no addition except sodium sulphite, but I have not been able to find any previous definite evidence that it will develop in a solution acid to litmus. So far as my own experience goes, eikonogen is in this respect unique amongst all the ordinary developers. Amidol and diamidoresorcinol do not develop in solutions acid to litmus, even when allowed to act for so long as 76 hours on plates that had much more than a normal exposure, though the addition of some sodium sulphite at the end of this time sets the developing action going at once. Probably other naphthalene derivatives analogous to eikonogen will behave in the same way as it does.

Phenylhydrazine is also an exception in that it will develop with some energy in a solution that is neutral to litmus, but I have not been able to obtain any developing action when the solution was acid to litmus. Hydrazine and hydroxylamine also will not develop if the solutions are acid to litmus.

Referring once more to the action of sodium sulphite, it is obvious that as all the ordinary developers will act in presence of the sulphite alone, this substance not only keeps the liquid from becoming discoloured, but also has a weak accelerating action of its own. Since, however, the rate of development in presence of an alkali sulphite is very much lower than when an alkali is added, it follows that in the operation as usually carried out, the accelerating effect of the sulphite is a practically negligible quantity. At the same time it ought not to be forgotten that sodium sulphite in moderately concentrated solutions has a distinct solvent action on silver bromide, and it is conceivable that this action may play some part in the process. At present, however, there is no direct evidence that this is the case.

In order to avoid the inconveniences attending the use of alkalis, and notably of caustic alkalis, Messieurs Lumière have proposed the use of tribasic sodium phosphate, Na_3PO_4, a salt which is fairly stable. When disolved in

water it splits up into the ordinary sodium phosphate (disodium hydrogen phosphate) and caustic soda, to an extent depending on the degree of dilution. Its effect is consequently the same as that of caustic soda, but the variations in the proportion of caustic soda present, that result merely from different degrees of dilution, introduce complications that are not without influence on the result.

Another novel and very interesting method of providing the necessary alkali has been devised by Messieurs Lumière. It is based on the well-known fact that aldehydes and acetones unite with acid sodium sulphite to form crystalline compounds. If to a solution of normal sodium sulphite containing pyrogallol or quinol, a small quantity of formaldehyde, or ordinary aldehyde, or acetone is added, interaction seems to take place with formation of aldehyde sodium bisulphite or acetone sodium bisulphite and the sodium salt of the pyrogallol or quinol. The change may be represented in this way—

$$C_6H_4(OH)_2 + 2\,Na_2SO_3 + \underset{\text{(Acetone)}}{2\,C_3H_6O} = C_6H_4(ONa)_2 + 2\,NaHSO_3.\,C_3H_6O.$$

At any rate the addition of the acetone or aldehyde confers on the solution powerful developing properties, the rate of action depending to a considerable extent on the proportion of aldehyde or acetone added.

The most satisfactory results for general purposes seem to be obtained with pyrogallol and acetone. A solution is prepared containing pyrogallol one part, sodium sulphite five parts, water 100 parts, and to this acetone is added up to an amount not exceeding ten parts. The developer works regularly but fairly rapidly; the method has some distinct advantages, and seems likely to become of considerable practical importance. Some examples are shown on the screen. Quinol and sodium sulphite, aad formaldehyde are said to yield a developer very useful where negatives with strong contrasts are desired, and paramidophenol also develops in presence of sulphites when an aldehyde or acetone is added.

The only other substance commonly added to developers is a soluble alkali bromide, the action of which varies according to the nature of the particular developer. It generally lowers the rate of development, but within certain limits as to the proportion added, its only other effect on the final result, when development is allowed to proceed to its limit, is, according to my experience, to reduce or prevent general fog. When development is not pushed to its limit, the bromide, if in sufficient quantity, has a materially influence on the character of the negative, as photographers have long believed, and as the later experiments of Hurter and Driffield seem clearly to prove. Broadly speaking the effect is the same as if the plate were somewhat slower, or had received a shorter exposure, but the matter requires further investigation.

Concerning the chemical changes that go on during development I propose to say very little, and, indeed, there is very little definitely to say. It is recognised in a general way that a developer is a reducing agent, and that the operation of development is a process of reduction. It is important not to forget that in its ideal form at any rate it is a process of *selective* reduction, and the ideal developer is one that will not reduce silver gelatinobromide that has not previously been exposed to light. In this case, as in so many others the real is often very different from the ideal, but the ideal is not unattainable even under ordinary working conditions, though it must be confessed that in the desire to obtain high sensitiveness the silver bromide in many gelatinobromide plates is brought into such a highly unstable condition that it is attacked by the developer even without any preliminary action of light.

It is also recognised that the developer undergoes oxidation, but no definite oxidation products have yet been satisfactorily isolated. The matter is especially difficult to investigate because only a small part of the change in the developer is due to its action on the photographic plate; the greater part is due to the action of the air on the developer.

Three chief hypotheses have been propounded concerning the nature of the change in the silver bromide. There is the view expounded by Abney that the undeveloped image consists of a minute quantity of silver sub-bromide, which is reduced by the developer to metallic silver; the silver thus liberated unites with the silver bromide that is in contact with it to form more sub-bromide, which in its turn is reduced yielding still more silver, and this in the same way forms more sub-bromide, which is again reduced, and so on. Secondly, there is the view that the reduction of the silver bromide is to be regarded as a process of electrolysis initiated by the minute quantity of silver that results from the action of the developer on the material forming the latent image. Lastly, there is the view of Hurter and

Driffield that every particle of silver forming the developed image is represented in the undeveloped or latent image by a corresponding particle of silver bromide that has been affected by light, and has thereby been thrown into a state of such unstable equilibrium that it is reduced by the developer; they accept neither the sub-bromide hypothesis nor the hypothesis of electrolytic action.

In considering the question, I think it is important to bear in mind that the chemistry of development is a chemistry of dilute solutions. An ordinary developer on an average contains 5 parts of the developing agent in 1,000 parts of solution, or a gram molecule in 22 litres. It is possible, however, to develop a normally exposed plate in a solution containing only 1 part of pyrogallol in 10,000 parts of solution, *i.e.*, a gram molecule in 1,260 litres, or a degree of dilution far beyond that which obtains in ordinary chemical operations. The first example exhibited was developed for 2 hours in a solution containing 1 part of pyrogallol in 5,000. The second was developed for 100 minutes in a solution containing 1 part of pyrogallol in 10,000, In explaining these phenomena it may be necessary to take into account the special properties of very dilute solutions.

The main reaction, whatever its mechanism, is of course the separation of bromine from silver, the metal remaining to form the image, whilst the bromine dissolves in the form of an alkali bromide. At the same time the developer is oxidised, apparently at the expense of the water that is present. The reaction does not seem to me to be one that can properly be represented by an ordinary equation; many attractions are at work tending to keep the system in its original configuration, whilst many counter-attractions are tending to bring about a change of configuration, that is, a re-arrangement of the atoms with the production of new substances. Under proper conditions the occurrence of any change at all is dependent on the initial change produced by the action of light. When a change does take place the reaction is not a reversible one, but nevertheless the relative masses of the reacting substances have a distinct influence; the change is accelerated within certain limits by an increase in the relative masses of the reducing agent and the alkali, but on the other hand it is retarded by an increase in the mass of alkali bromide, which is one of the products of the reaction. In some cases also it seems to be retarded by the product of the alteration of the developing agent. The whole question has been the object of much speculation—and a little experiment—but many of the problems that it includes have still to be solved.

DISCUSSION.

The Rev. F. C. LAMBERT said one of the most interesting points mentioned was the developing power of hydrogen-peroxide. Most present would be aware probably of the interesting experiments recently made by Dr. Russell on so-called photography in the dark. He understood him to say in a recent lecture at the Royal Photographic Society that he was tending to the opinion that all these curious actions could be traced to the elimination or production of hydrogen-peroxide, that the substances which acted on the photographic plate in the dark were those which gave off hydrogen-peroxide.

Sir H. TRUEMAN WOOD said this subject required for its discussion much greater knowledge of organic chemistry than most people possessed, and he rather regretted that the paper had been fixed for that evening, when many chemists who might otherwise have been present were enjoying themselves elsewhere at the annual dinner of the Royal Society. The average photographer would probably look at the paper in three different ways. First of all he would be struck by the clear and brilliant way in which Mr. Bothamley had treated a subject of great difficulty and complexity; next he would be led to hope these researches would throw some light on the very abstruse phenomena of photographic development; and lastly, he might be tempted to despair on finding how little was really known of those phenomena, and how empirical was the knowledge which had been gained. Seeing that three or four theories had been put forward as to the nature of development itself, how could they expect to know the action of the various substances which were used as developers. The practical question which would occur to many of them would be what was the good of having so many developers, and were any of them any better than their old friend pyrogallol? The practical man would say that the results produced by these newer agents were not very different from those produced by the older ones, and that although metol, for instance, might give you the power of bringing out more easily an image which had been very slightly exposed, the actual benefit derived from the additions to the list was not very great. There was, of course, a great advantage in having for certain purposes, developers which did not stain. Perhaps Mr. Bothamley could tell them why pyrogallol stained the plate or paper more than metol or hydroquinone or some of the other substances; whether the more rapid oxidation of the pyro produced a dye which stained any material to which it came in contact, he for one would like to know. He

hoped some practical photographers would give their opinion as to benefit derived by having so many different materials placed at their command, but he fancied that nine-tenths of the work was still done with pyrogallol, and that those newer developers were, to a large extent, used by amateurs and experimentalists.

Mr. W. BROOKS said he had used acetone pyro for the last six months, and found that it would do all that alkaline pyro would do, and a great deal more. It had rather a tendency to soften the film, which he did not like, but it had the great advantage that it did not stain the hands, which made it very suitable for ladies. He had also used glycin, which was superior to anything he knew of, from the point of view of gradation. Some time ago he had to photograph the memorial plate to a Lord High Admiral (Lord Howward of Effingham) in the church at Reigate, the colour of the plate being that of burnt sienna, and the letters black, and he thought it was almost a hopeless case, but to his surprise all the letters came out like an engraving. Amidol was another developer which he had found useful. Many people thought glycin was only suitable for line work, but he found it gave the most delicate details possible. With regard to Dr. Russell's experiments with metals, he might say that he worked on that subject, at the latter part of the sixties and beginning of the seventies, and he thought Dr. Russell would find that the effect depended on the distances at which the elements were placed in front of the plate; there was a sort of photosphere produced which caused the action, which did not take place when there was actual contact. With zinc the distance might be $\frac{1}{8}$ inch, and with iron $\frac{1}{2}$ inch, but with each metal there was one plane in which the action was most marked.

Mr. KROHN asked whether precautions had been taken in the case of the acetone experiment, to see that the sulphite was pure and contained no carbonate. A friend of his some time ago experimented in this direction though he was not able to conclude his researches. As far as he remembered he tried both acetone and formalin, and in both cases obtained development, but on neutralising or adding sulphurous acid to the sulphite, so as to get rid of all traces of carbonate, the action was reduced, if not altogether stopped. This was a point frequently ignored, but commercial sulphite sometimes contained as much as 25 per cent. of carbonate.

The CHAIRMAN said he could not follow the chemistry of the paper in detail, but Mr. Bothamley had done a great service to photographers in preparing it, and it would afford a valuable basis for further research. He had tried most of these developers in a more or less experimental way, but could not say much about them; after all he thought the old friend pyro was the real stand-by of the photographer, though a good word might also be said for ferrous oxalate. This had one advantage over organic developers, that you knew exactly what you were working with; the others, especially in tropical climates, were liable to decompose. In India the great difficulty was to keep things fresh; sometimes the pyro looked nice and white, but when put into water it gave a dark-brown or almost black solution. Eikonogen, which he had also used, sometimes appeared as a brilliant purple blue powder. Ferrous oxalate for a long time was the favourite on the Continent, and was largely used there, but was not much used in England. Glycin was valuable when you knew how to use it, and he liked it very well for certain purposes though it was said to be slow. With regard to guaiacol, it showed how easy it was to mistake the action of an impurity for that of the substance with which it was mixed. When he was working with guaiacol it was not so commonly used as now for medical purposes and was not so pure. Lumière showed that *pure* guaiacol had no developing power, and it seemed likely that the developing action was due to minute traces of pyrocatechin, which he had found by experiment had considerable developing power, even when reduced to $\frac{1}{50000}$ inch, and 1 per cent. solution of caustic potash. Carbolic acid or phenol was another case in point. The pure phenol was not a developer, but samples of carbolic acid, that had been kept for some time and turned red, had considerable developing power. Cresol paracresol, and phlorol had also some power of development. Hydroxylamine hydro-chlorate was also an exceedingly valuable developer if you could use it, but the difficulty was to prevent the little bubbles and blisters; this defect had prevented its use. He had lately used pyro-acetone, which gave good density and tone and freedom from stains, but he found it had a tendency to frill and reticulate, at any rate in the summer. One of the nicest developers was paramidophenol hydrochlorate; it was something like rodinal, but he preferred the salt itself. It was very good for office use, because you could put your plate in, go away and attend to visitors, and come back and find the plate all ready. It had also great keeping powers, and was always ready for use. Eikonogen was also useful for ordinary work and in making reversals. He thought it was a good thing to have a large choice of developers, because one would serve best for one purpose and another for another, but it required experience and skill in making a selection. Metol had become popular because it was a snapshot developer, which could be used after very short exposures, or in places where the light was weak.

Mr. BOTHAMLEY, in reply, said as far as he could form an opinion, Dr. Russell had practically proved that the pseudo-photographic effects he had noticed were due to the action of hydrogen-peroxide in very small quantities on the plate. It was well known to be

formed in almost all cases where a metal, or anything else—varnish, for instance—was oxidised in the presence of air. He had himself repeated some of Dr. Russell's results and found that very small quantities of hydrogen-peroxide would produce very dense latent images; that is to say, latent images which, when developed, showed considerable opacity. It had also been shown long ago by Captain Abney, that hydrogen-peroxide, in solution, would destroy the latent image if it were allowed to act on the photographic plate. In a paper read at the British Association he (Mr. Bothamley) had shown, not only that hydrogen-peroxide vapour, if allowed to go on acting, would, in time, destroy the image that it had first produced, but that turpentine and one or two other substances would do the same thing. Hydrogen-peroxide would produce a latent image, destroy it, and develop it, according to the conditions under which it acted. Years ago it was shown by Brodie that hydrogen-peroxide would act sometimes as a reducer, and sometimes as an oxidiser, and in one and the same liquid it would be reducing and oxidising at the same time. With regard to the practical result of researches of this kind he thought they were distinctly useful, mainly because they showed in what direction to look for new developers. Metol, which was to a certain extent the outcome of this work, was a distinct gain, as it was very useful for special classes of work, difficult interiors, and the like. It was a great advantage to have substances which did not stain, such as metol, paramidophenol, and others. They gave images on a gelatine bromide plate, which had always practically the same colour, which was not the case with pyrogallol; there the colour was more or less brown, but it varied a great deal. With metol and other substances the colour of the image was almost always the same; it was only the degree of opacity which varied. Why some developers produced stains and others did not, was a difficult question. Why one dye would dye wool and another cotton, and why some would dye gelatine and others would not, were questions which he doubted if any chemist could answer at present. Some years ago, when making experiments in orthochromatic photography, he observed frequently that some of the eosin dyes would readily stain gelatine a deep colour, and certain others would not, rhodamine for example. There was no doubt that many of these new developers, like metol, were not acted on by the oxygen of the air to anything like the same extent as pyro and some others. A solution of metol or of catechol, with a very little sulphite in it, might be left exposed to the air for a long time without showing any marked colour. Amidol, though it produced a deep colouring matter by the action of the air, did not apparently stain gelatine, nor did it stain the fingers. Ortol, which he used largely for lantern slides and bromide prints, was also remarkable for its freedom from stains. Probably the great majority of negatives were still developed with pyrogallol. When Dr. Paul Liesegang was last in England he told him that he believed in Germany they had gone back to pyrogallic acid for all practical purposes, except in those cases where they still used ferrous oxalate. His own opinion was that metol, ortol, amidol, and paramidophenol were all distinct practical gains, and glycin also was very useful. With regard to the acetone experiments, the sulphite contained no carbonate. Although the solution was not alkaline to phenolthalein, to make quite sure he added a small quantity of metabisulphite of potassium, a strongly acid salt, and still the development went on very rapidly, even with a small quantity of acetone. It was a new thing, and wanted working out, but he thought under proper conditions it might be very useful. It was much more convenient to have a small bottle of acetone than a big bottle of soda solution, and you escaped all the unpleasantness of using a caustic alkali. There was no difficulty now in obtaining at a moderate price, under 1s. per pound, sodium sulphite, which contained only a small trace of carbonate. Of course you must be careful where you obtain it because he knew that some of the so-called commercial sulphites were the greatest rubbish. He thought it probable that the guaiacol used by the Chairman was a vegetable product, because at that time synthetic guaiacol was not readily obtainable; it was probably far purer than the natural product.

Mr. HOWARD asked why metol acted on the fingers, and if anything could be done to prevent it.

Mr. BOTHAMLEY said he believed it was a question of idiosyncrasy. He had found no ill effects himself from using it; but, on the other hand, he knew that some few people did experience serious skin trouble from it.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Bothamley, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

A TALLOW LAMP FOR GLASS-BLOWING, AND OTHER BLOWPIPE WORK.

By THOMAS BOLAS, F.C.S. F.I.C.

Before coal gas came into use, glass blowers used a lamp containing tallow or other fatty fuel, and after a long period of almost complete disuse such lamps are once more becoming important; electric lighting having replaced gas in so many houses and public buildings.

The chief disadvantages of the old forms of tallow lamp having one large wick of soft cotton are as follows:—1. A flame with a very

large hollow is obtained, and the partially vaporised and decomposed tallow contained in the large hollow tends to blow out sideways, and give a ragged reducing flame. 2. There is a rapid burning away of the wick at the edges; this necessitating trimming and involving considerable and troublesome variations in the character of the flame. 3. The flame cannot be regulated rapidly, especially as to its fitness to furnish a small or large blowpipe flame as required.

The above disadvantages of the tallow lamp all disappear in the case of the form described below. The new form gives a blowpipe flame fully equal to the best gas blowpipe flame; and the lamp being once adjusted to the character of the flame required will remain constant for half an hour or more.

The new tallow lamp consists merely of a tin-plate tray open at the top, 1 inch deep, $1\frac{7}{8}$ inches wide, and $3\frac{1}{2}$ inches long, through the bottom of which 5 flat air-shafts $\frac{1}{8} \times \frac{7}{8}$ inch rise, and these air-shafts terminate level with the top of the tray; so that if one looks downwards on the lamp it appears as shown by Fig. I. The tray being filled with tallow (or any fat oil may be used) pieces of the compact cotton wick used for mineral oil lamps and cut to a length of 1 inch, are placed between the air shafts and lighted. Naturally one large flame is formed; but the air rising through the shafts so breaks up the central hollow, and so far brings the combustion into a smaller area, that little difficulty is found in so adjusting the air jet or blast as to obtain a good blowpipe flame, and the hard wicks, being well within the flame, scarcely suffer after many hours use. The soft wick ordinary found to be essential for use with the tallow lamp is undesirable in this case.

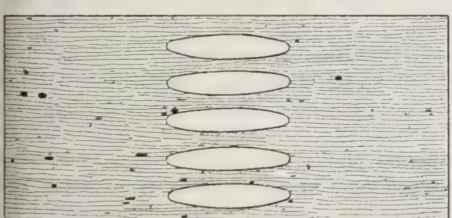


Fig. I.

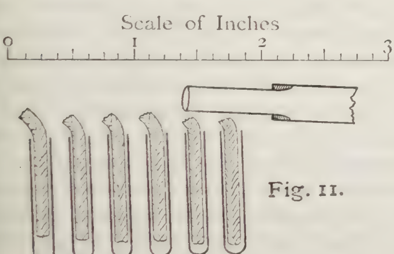


Fig. II.

Fig. II. shows the approximate position of the six wicks (1 inch wide) and air-jet which are used when we require the largest blowpipe flame which can be maintained by one person's blowing: the air jet in this case being nearly a quarter of an inch in diameter; but for smaller flames fewer and narrower wicks should be used. For example, an air-jet one twenty-fifth of an inch in diameter will require three wicks, each wick being one-fourth of an inch wide. The spaces between the air-shafts are so wide, as to allow the wick—as ordinarily used for mineral oil lamps—to be easily removed or changed by a small pair of tweezers, but so close as hinder any tendency to shift and disturb the adjustment. A slight adjustment of one wick or more can be made with the tweezers instantly and while the blast is maintained, so the adaptation of the fuel to the air becomes almost as easy as with coal-gas and a stopcock. It will be remarked that the lamp-body which I recommend is very small, and this necessitates the frequent dropping of fresh lumps of fuel into the open ends of the lamp-body, a matter of no inconvenience when solid paraffin or wax is used and the material is at hand in small lumps. Tallow is ideal as far as the character of flame is concerned, but it is messy to handle, and productive of smoke and smell. Paraffin-wax and white bees-wax are open to neither of these objections, and can be used in any house, or even drawing-room, without inconvenience.

The lamp, as I have made it, stands in an outer tin plate tray about a foot square, and the bottom of the lamp is an inch-and-a-half or so above the tray. The front of the tray carries the air-jet with universal motions for adjustment, and a plain cover fitting loosely over the lamp, serves not only as a general extinguisher, but also to extinguish any burning wicks which may be taken out of the lamp and laid on the tray. I find it convenient never to trim the wicks, but to soak the stock of wick in paraffin-wax, and then cut it into 1-inch lengths; replacement of an old wick by a new one being far quicker and more convenient than trimming. As before mentioned, the wicks last a long time, and in practise they are more often changed (one at a time, and while the lamp is burning) to suit a new air-jet, than because hardened or charred at the top; and the wick material is so cheap that it is scarcely worth while to put back a wick that has been once used.

For flames considerably inclined upwards or downwards, the lamp may be trunnioned at the ends; but a tilt of about 15 degrees is the utmost practicable, as in this case the highest wick would be at least half out of the liquid fuel. Longitudinal division at the second and fourth air-shafts will make the tilted lamp like a canal divided into three locks, and now a tilt of over 45 degrees can be given without inconvenience. Adaptations of this kind are so obvious as scarcely to require mention.

Paraffin wax of low melting is better than the more expensive kinds which melt at a high temperature, and in practice it is often convenient to purchase the cheapest paraffin candles, to split them longitudinally, tear out the wicks, and to break the material into lengths of about an inch.

THE ITALIAN HEMP INDUSTRY.

It is unquestionable that hemp is the most remunerative of the agricultural products of Italy, partly on account of its own value and partly because the large amount of residuary matter is subsequently of great value to the farmer. Wherever land is suitable for its cultivation we are therefore sure to find it, and the Government statistics calculate the annual yield at 70,000 to 75,000 tons. That this calculation very much under-estimates the quantity grown seems tolerably certain, for the returns from the province of Emilia show 40,000 tons; Naples and Caserta, 18,400, which would only leave 11,600 for the provinces of Bologna and Ferrara, which are notoriously the chief producers of the article. Consul Neville-Rolfe, of Naples, says that to take those statistics which concern his consular district the sum of 18,400 tons of produce is manifestly too small, for the export trade alone shows an average of 16,000 tons, which would only leave 2,400 tons to supply the large factories of Sarno and other places as well as the considerable quantities consumed by local rope walks and other small industries. The hemp of Bologna is especially noted for its great length of fibre, which is due to the unusual height (13 feet) to which the plant grows in that region. It possesses particular strong and tenacious properties. The Naples hemp coming from lower but thicker plants is more delicate, has the merit of greater fineness, and is particularly in request for the whiteness of its fibre. In fact the different classifications, which are called, according to quality, "homespun extra 1 and 2" and "cordage 1 and 2," are made up specially according to their colour, and naturally also according to the fineness of their fibre. Heavy rain when the crop is cut and lying out to dry is one of the most serious misfortunes which can befall the farmer, as his produce loses whiteness of colour, and hence falls in quality. There are a certain number of varieties of hemp all easily propagated and crossed, as the plant bears male flowers producing the pollen or fertilising powder, and the female, from which the seed eventually comes. Hence in a region where cultivation of hemp is carried on on a large scale, the seed of one variety may easily become fertilised by the pollen of another. This leads to the crossing and fusion of all kinds. In the Naples district, whether the hemp of Carmagnola, of Bologna, of Ordei, or Pilosella, or any other kind, is sown, the plants, after two or three generations, lose their characteristic qualities, and it becomes necessary to import fresh seed from a district where only one kind is grown. Agriculturists divide the varieties of hemp into two groups, "La Gigante" (the Giantess) of tough fibre, and the "Dwarf" Nana or Ortichina (small nettle) which is lacking in fibre, and whose seed is specially used for the production of oil. But the difference between these two varieties soon disappears when they are subjected to a different cultivation from that which they have been accustomed, and this without taking into consideration the effect of propagation and crossing by pollen. In practice it is most difficult to distinguish one variety from another, judging by the seed alone, and *à propos* of this, Dr. Todaro of the Agrarian Station of Modena, observes in a recent publication, that not even from the weight of the seed, or from the best sample of fruit, can one arrive at a sure conclusion, seeing that from experiments made by him on various samples in the average weight of 100 seeds of the giant hemp and 100 seeds of the dwarf hemp the difference was hardly perceptible. He cites a series of minute marks in which the two varieties differ from each other after the germination of the seed, and at the end notes how the dwarf hemp when sown in a pot and kept in a place purposely heated, flowers much sooner than the giant variety, and on an average within a month of being sown. Special experiments should be made to test the difference in richness of oil obtainable from the different varieties, in order to make quite sure that the dwarf hemp is in reality a better oil producer than the giant variety. Foreign demand for Italian hemp has been regularly on the increase, although the price since 1875 has been regularly on the decline. The cause of the fall in price is the ever increasing competition of jute hemp, largely cultivated in the East Indies, the hemp called manilla manufactured from the *Musa Textilis*, and the fibre textures of the ramine or *Boehmeria nivea* of China. Besides this, the diminution in sailing vessels, and the consequent decrease in the demand for canvas and rope, gave a great blow to the demand for hemp, although nothing up to the present has been found that can take its place in the manufacture of strong linen or running gear, for no plant surpasses it in the production of fibre of great length and tenacity. In spite of this, the export of hemp has always been on the increase, and since 1892 the exports from Italy have increased considerably. During the past ten years the cultivation of hemp has been gradually extended in the province of Terra di Lavoro to such an extent that at the present time the land between Capua and the sea, formerly given up to pasture and growing of corn, is now under hemp cultivation; the same applies to the land to the right of Volturno, where not many years ago the names of the towns of Capua and Teano were almost unknown as hemp-producing districts. In the districts of Bologna any Ferrara, and in the frontier provinces of Emilia and Rome, as well as in the lower part of Venice, the great increase in grants for reclaiming ground has transformed thousands of acres of marshes into arable land, of which a great part has been given up to the cultivation of hemp, and this increase of acreage is enough to account for the increased production. Italian hemp is said to be now taking the place of the Russian article on the different European markets simply on account of its great superiority in quality. Consul Neville-Rolfe says that one regrettable result of the increased cultivation of hemp has been the large increase of malaria in the districts where it is

grown. The hemp is cut, its leaves stripped off it, and then it is placed in ponds and weighted with large stones. These ponds give out miasmatic exhalations to such an extent as to make their neighbourhood uninhabitable. Indeed, the plant has in all conditions a poisonous effluvium, for at the end of the last century, when the British and Neapolitan armies were besieging the French at San Elmo, severe sickness broke out among the British troops, which was clearly traced to the fact that they had built their huts of hemp from the adjoining fields.

THE PINE-APPLE INDUSTRY OF THE BAHAMAS.

After sponge, the most important productions of the Bahamas are pine-apples, of which no less than nearly 5,000,000 were shipped to the United States in 1897. The report of the Acting Colonial Secretary states that they are chiefly grown in the islands of Eleúthera, San Salvador, and Long Island; but nearly every island of considerable size possesses soil which is suited to the cultivation of pine-apples. The species produced is known as the "scarlet" or "red Spanish," and is of inferior quality. It is, however, a good traveller, and four-fifths of the output of these islands go to the canning factories of Baltimore. The methods of cultivation are exceedingly primitive. As many as 20,000 plants are crammed into an acre of more or less rocky ground, and it is only during the last three or four years that chemical fertilizers have been used in these fields. In most cases the pine-apples are grown on the *metayer* system, the owners of the large tracts of land sharing with the cultivators the crop of fruit. These proprietors make advances in cash or provisions to the labourers until the reaping of a crop, and the cultivator is precluded, under an agreement, from selling his share to any other than the landlord. The price to be paid for the fruit varies from 1s. to 1s. 6d. per dozen, according to the date of production; and as the cultivator does not receive more for a fruit weighing six pounds than he does for one that is only half the size quantity and not quality is the object of his labours. From eighteen months to two years must elapse between the planting and the reaping of a crop of pine-apples, and in that interval the cultivator will have required so many advances in cash and provisions for the maintenance of his family that his account with the landlord in the shipping season is very often on the wrong side. This system is open to much objection. Apart from the unsatisfactory transactions in truck, the method acts as a bar to any improvement in cultivation, and tends to the elimination of any independence on the part of the labourer. When ripe the pine-apples are cut and carried on the heads of men and women to the beach nearest the plantation, where they are shipped in large American sailing vessels. The Acting Colonial Secretary says it will hardly be credited that in most cases the fruit is shipped in bulk in the ship's hold, and as a large schooner will carry from 75,000 to 150,000 pine-apples, the condition of the fruit in the lowest layers, when it arrives in Baltimore, after a 10 days' passage, may be better imagined than described. In spite, however, of these intensely primitive methods, the pine-apple cultivation in the Bahamas is one of considerable profit and importance to the colony; but there is every reason to believe, if more care were taken, and a superior grade of fruit cultivated, the results would be manifestly more profitable to every one concerned. Tentative efforts are now being made to encourage the cultivation of the finer varieties of pine-apples, and there seems to be no reason why the London market, which is now principally supplied by the Azores and the Canary Islands, should not provide a profitable outlet for Bahamas fruit of a superior grade. Factories for the canning of pine-apples have lately been established in Nassau and in Eleuthera, and in 1897 they shipped more than 20,000 cases of preserved fruit.

General Notes.

MOTOR-CAR SERVICE IN FRANCE. — The first goods and passenger service by automotor cars has been established between the Montmedy and Stenay stations in the French department of La Meuse, a distance of 19 kilometres (12 miles). The pace is not to exceed 20 kilometres ($12\frac{1}{2}$ miles) per hour; and there are to be three departures in each direction daily. The passenger fares must not be more than 10 centimes per kilometre ($1\frac{1}{2}$d. per mile); and passengers taken up on the way will be charged from the last stopping place, while those so getting down will be charged to the next stopping place. Luggage will be carried free up to 30 kilogrammes (66 lb.) for every ticket of 60 centimes (6d.) and upwards, while excess will be charged at the rate of 1 franc per ton per kilometre, with a minimum of 40 centimes (4d.).

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at 8 o'clock:—

DECEMBER 7.—"Egypt and the Soudan, in 1897 and 1898." By W. T. MAUD, Artist and Correspondent to *The Graphic*. MAJOR-GEN. SIR OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., will preside.

DECEMBER 14.—"Commercial Education." By SIR ALBERT ROLLIT, LL.D., M.P.

Papers for meetings after Christmas:—

"Tuberculosis in Animals." By W. HUNTING.

"Canals and Inland Navigation in the United Kingdom." By L. F. VERNON-HARCOURT, M.A.

"Preservation of Timber." By S. B. BOULTON.

"Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

"Leadless Glazes." By WILTON P. RIX.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at 4.30 o'clock:—

December 6, January 24, February 28, April 25.

At the meeting before Christmas the following paper will be read:—

TUESDAY, DECEMBER 6.—"The Yangtse Basin and the British Sphere." By ARCHIBALD LITTLE, F.R.G.S., of Chungking. The Right Hon. SIR RICHARD TEMPLE, Bart., G.C.S.I., C.I.E., will preside.

*** Numerous lantern slides of the Upper Yangtse and beyond will be shown and described by Mrs. LITTLE.

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

PROF. VIVIAN B. LEWES, "Acetylene." Four Lectures.

LECTURE III.—DECEMBER 5.

The commercial generation of acetylene—The types of generator in use—The actions taking place in acetylene generators, and the effect upon the gas produced—The purification of acetylene for domestic consumption.

LECTURE IV.—DECEMBER 12.

The combustion of acetylene—Acetylene burners—Smoking and carbonising of burners—Burners for heating—Acetylene for gas engines—Diluted Acetylene and its applications.

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

January 16, 23, 30, February 6.

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

February 20, 27, March 6, 13.

PROF. HENRY R. PROCTER, "Leather Manufacture." Four Lectures.

April 10, 17, 24, May 1.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian Lewes, "Acetylene." (Lecture III.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. George Thudichum, "Bacterial Treatment of Sewage."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Colonel W. J. Engledue, "Oxone and its Commercial Applications." 2. Mr. Arthur Marshall, (*a*) "An Improved Apparatus for the Estimation of Carbonic Acid in Minerals, &c."; (*b*) "The Preparation of Standard Solutions of Sulphuric Acid."

Imperial Institute, South Kensington, 8½ p.m. Sir J. Benjamin Stone, "A National Photographic Record."

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned discussion on the paper by Mr. H. T. Eve, "Compensation Values of Cattle Foods—Chemist *versus* Valuer," will be resumed.

British Architects, 9, Conduit-street, W., 8 p.m.

Japan Society, 20, Hanover-square, W., 8 p.m. Mr. S. Kajima, "The Art of Flower Arrangement in Japan."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. Theo. G. Pinches, "Recent Discoveries on Babylonian Tablets."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. A. Kennedy, "The Story of Canada."

TUESDAY, DEC. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Foreign and Colonial Section.) Mr. Archibald Little, "The Yangtse Basin and the British Sphere."

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Pathological, 20, Hanover-square, W., 8½ p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Colonial Inst., Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Dr. Alfred P. Hillier, "The Native Races of South Africa."

WEDNESDAY, DEC. 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. T. Maud, "Egypt and the Soudan, in 1897 and 1898."

Geological, Burlington-house, W., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, DEC. 8...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Josiah Booth, "Humour in Classical Music."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Prof. Oliver Lodge, "Improvements in Magnetic Space Telegraphy;" and if time permits—Mr. Sydney Evershed, "Telegraphy by Magnetic Induction."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, DEC. 9...Astronomical, Burlington-house, W., 8 p.m.

Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Mr. E. A. Heath, "British Cable Tramways and their Construction."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Dr. C. Chree, "Longitudinal Vibrations in Solid and Hollow Cylinders." 2. Mr. J. Rose-Innes and Dr. Sydney Young "The Thermal Properties of Normal Pentane."

SATURDAY, DEC. 10...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

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FRIDAY, DECEMBER 9, 1898.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, 1899, at 7 o'clock, by Professor F. Jeffrey Bell, M.A. (of the Department of Zoology, British Museum). The first lecture will be on "Hands and Feet," and the second lecture on "Some Ways in which Animals Breathe." The lectures will be fully illustrated with lantern slides.

A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received. Subject to these conditions each member is entitled to a ticket admitting two children and an adult.

The tickets for the lectures are now ready, and can be had by members on application.

CANTOR LECTURES.

On Monday evening, 5th inst., Professor Vivian B. Lewes delivered the third lecture of his course on "Acetylene." The lectures will be published in the *Journal* during the Christmas recess.

FOREIGN & COLONIAL SECTION.

Tuesday afternoon, Dec. 6, 1898; The Right Hon. Sir Richard Temple, Bart., G.C.S.I., C.I.E., in the chair. The paper read was "The Yangtse Basin and the British Sphere," by Archibald Little, F.R.G.S., of Chang-king.

Numerous slides of the Upper Yangtse and beyond were shown and described by Mrs. Little.

The paper will be published in a future number of the *Journal*.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 7, 1898; Major-Gen. Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Granger, Arthur Otis, Girard-building, Philadelphia, U.S.A.

Johnson, Alexander Banks, Bringewood, Mulgrave-road, Sutton, Surrey.

Kitching, Henry, J.P., The Grange, Great Ayton, Yorkshire.

Lutwyche, Stanley, 3, Chichester-terrace, Brighton.

Stevens, Charles, 10, Wemyss-road, Blackheath, S.E.

Winch, Richard, Morden-grange, Kidbrook, Blackheath, S.E.

The following candidates were balloted for and duly elected members of the Society:—

Aström, Carl A., 83, Cannon-street, E.C.

Baylor, Armistead Keith, 23, Cadogan-gardens, S.W.

Cole, Philip Henry, 20, Lessing-street, Honor Oak-park, S.E.

Courtney, Charles Frederick, Central Mine, Broken Hill, New South Wales.

Leach, Herbert Louis, 28, Leigham-court-road West, Streatham, S.W.

Magnus, Sir Philip, 16, Gloucester-terrace, Hyde-park, W.

Spencer, John W., Newbiggin-house, Kenton, Northumberland.

Strutt, Denner John, The Firs, Strawberry-hill, Middlesex.

Thomas, Richard Beaumont, J.P., Dennel-hill, Tidenham, Gloucestershire.

Van Raalte, Jacques, Holland-house, Broadwater Down, Tunbridge Wells.

The Chairman, in introducing Mr. Maud, said that although still young, he had already been as special war correspondent and artist of *The Graphic* through something like seven campaigns. He was in Constantinople at the time of the Armenian sacrifices, he was in the Greek War, twice in the Soudan operations, and in the expedition on the North-West Frontier, so that he would be listened to with a great deal of interest.

The paper read was—

EGYPT AND THE SOUDAN IN 1897-98.

By W. T. Maud.

The battle of Omdurman is still fresh in our memories, it will stay with us until our dying day, it will adorn for ever one of the brightest pages in the history of the British Empire. It stands by itself as a great and glorious fight.

Yet, in reality, it is nothing more than the brilliant climax of a grand drama: the supreme moment that is only attained after a series of acts which, taken separately, are not remarkable for exciting scenes or stirring incidents. The acts to which I refer are the campaigns of 1895, 1896, 1897, 1898. Each one is the sequence of its predecessor, each one is stamped with the same characteristic feature—progress. The period of defeat, dishonour, and retreat was ended, and a new era had dawned in the dark history of the Soudan.

The comprehensive treatment of so vast a subject as the overthrow of Mahdism is a manifest impossibility within the limits of a single lecture—I might even say within the limits of twenty lectures. Therefore I propose to-night to deal more particularly with the picturesque features of the final campaign in the Soudan, and of that which immediately preceded it.

It was in the month of July, 1897, that I left London for the Soudan to take part in the advance on Omdurman. I was filled with enthusiasm at the prospect of a campaign in that land of battlefields, and of marching side by side with British officers, so many of whom had already earned high reputations for their qualities of fighting, keenness, and organisation. The prospect was made the more pleasureable to me by the fact that only six weeks previously I had witnessed all the disasters that had befallen the Greek army in Thessaly, an army in which those soldierly qualities I have just mentioned were so conspicuously absent.

My first glimpse of the Egyptian army was gained in the workshops of the Citadel at Cairo. This ancient fortress crowns the crest of a bare rock hill to the eastward of the city, and the view from its battlements is one of the grandest in the world. At one's feet lies Cairo, a glittering mass of masonry, beautified throughout its broad extent by the golden domes of the mosques, the tall and graceful minarets, and countless gorgeous palaces. In the distance the grand old Nile rolls up from the South, and beyond the dark line of palm trees on its banks, rise the wondrous Pyramids of Gizeh, floating like phantoms in the heat-haze of the desert.

Within the Citadel lie stored a host of interesting relics of past magnificence; indeed, each stone of the crumbling wall has a history of its own; but these things are beyond my province altogether. I went there to see the Arsenal, the cradle of Egypt's young army, and I found it amidst the ruins of her ancient power. The dry bones had received the breath of life once more, and every workshop rang with the busy hum of toil, as it did in the days of Mehemet Ali. This great work of resuscitation was inaugurated four years ago by Major S. Gordon, R.E., the nephew of the great General Gordon, and it is under his careful supervision that the Arsenal has developed into a complex and efficient machine, thoroughly up to date and in full working order.

In passing through the various departments, one is struck by the fact that economy, and economy of the very strictest kind, is enforced throughout the establishment. For instance, here one sees the old brass Martini cartridge cases being melted down and the metal made to do new service in various ways. In one of the workshops I saw two or three men repairing bugles, and the means employed by them most certainly possessed the virtue of simplicity. The workman took up a broken and crumpled trumpet which had once been used in Arabi's army, and into the mouth of it he dropped a number of bullets, each slightly bigger than the preceding one. He then began to shake the trumpet up and down until first one and then another of the balls was forced through the dent by the weight of those behind them, and in this manner the tube became gradually straightened out. Close by these workmen a little boy squatted on the ground and manipulated a goatskin bellows, which communicated with a charcoal fire laid inside an old water-bucket. This primitive apparatus served as a forge for the trumpet menders, who thus heated their soldering irons. There were several of these bugles mended and polished hanging on the wall ready to be sent to a battalion, and no one but an expert could have told they were not brand new. The next department I went into was also a sample of economy. Martini rifles that had been worn at the muzzle by the cleaning rod were being cut down and converted into carbines. The director of the armoury told me that their shooting qualities remained excellent up to 500 yards, which is of course an extreme range for cavalry. The old and new fashioned methods of constructing war material are clearly demonstrated when one passes from the small arm factory with its trim and neat machines into the old gun foundry used by Mehemet Ali. The place is lofty, dark, and picturesquely tumble-down, but the huge beams and ponderous wheels with which the guns were bored and moved about

still stand as they were left by the old warrior. In his day the motive power was supplied by buffaloes harnessed to a wheel, but now steam and oil engines set every kind of machinery in motion. In the Citadel there are many workshops and departments, but they are not in themselves of any great importance, though each one plays its part, however humble it may be, in the reconquest of the Soudan. With a visit to the Citadel, one may say that the military interests of the city are exhausted, for with the exception of a British battalion at the Kase-el-hil Barracks, and the Khedive's bodyguard, there are no soldiers to be seen in Cairo. The Egyptian army is concentrated in the Soudan, one day fighting the Dervishes, the next building railways, hospitals, and barracks in the reconquered territory, and establishing civil government. We will therefore pass at once from Cairo to Wady Halfa, which is, or rather was in 1897, by far the most important town upon the Nile. Wady Halfa is the most unpretentious city in the world, but it is, nevertheless, a most remarkable one. It marks the highest point reached by the wave of Mahdism, which rose in Central Africa and swept northwards to Egypt, carrying all before it. Here the Dervishes surged around the loopholed fortifications which surround the town, and after many vain attacks, they retired to Dongola. Wady Halfa then had rest, and its aspect began to change. From being nothing more than a frontier fortress, it developed into a railway depôt. Lord Kitchener was then Sirdar, and he initiated the grand principle of fighting the Dervishes by railway. He had been with Lord Wolseley in 1884-5, and he had seen the disastrous results which were brought about by lack of adequate transport. He had seen that the necessaries of a civilised army, sufficiently powerful to reconquer the Soudan, could never be brought to it over the burning desert by camels alone. He, therefore, commenced to build the railway which now ends at Kerma, and which enabled him in 1896 to reconquer the province of Dongola. Dongola taken, the Sirdar then set out from Halfa with another railway for Abu Hamed, on the south side of the Nubian desert. Abu Hamed at that time was in the hands of the Khalifa, but that fact made no difference to the plans of the Sirdar. With sublime self-confidence he set himself the Herculean task of crossing 225 miles of sandy wilderness. It was a huge fight against the forces of nature, but the Sirdar won it, and thereby saved us many battles against the Dervishes

When I arrived at Wady Halfa the railhead had already eaten its way 100 miles into the desert. One day in the Sapper's Mess I heard that water had just been found at No. 4 station. The young subalterns of Engineers, who built this line, were jubilant at the result of their well-sinking, for every one, including the indigenous Arab, had laughed to scorn the notion of finding water in the heart of the desert. I received an invitation to run out to railhead and inspect the workings, and this opportunity I eagerly embraced. From the time that the train steamed out of Halfa until it rolled into the railway battalion camp, there was always something to wonder at and admire. Three colleagues and myself embarked in a carriage marked "saloon," attached to the end of a long train laden with every kind of railway plant. Our "saloon" had no cushioned seats or chairs, it would not be accepted in England as a third-class carriage, but it was roomy and airy, which is all that a traveller wants in the Soudan. The engine which drew our train was a new machine, built on the "bogey" system. It had lately come out from Englasd in small pieces, and it had been fitted together in the workshops at Halfa. It weighed over sixty tons, and it was capable of pulling 300 tons. The gauge of the permanent way is 3 ft. 6 in., exactly the same as that of the Cape railways, which it is destined some day to meet. Next to the engine came five bogey trucks, each one bearing an enormous iron water-tank. Behind them was attached the remainder of the train, which was made up of trucks filled with sleepers, rails, telegraph poles, and food for the railway battalion. It will give some idea of the enormous difficulties which beset the construction of this desert railway, when I say that each of the 3,000 men who were always at work upon it consumed three gallons of water a day—that is, 9,000 gallons a day. The engine which runs out from Halfa and back had to take sufficient water for a 30 hours' run, and another engine, which was permanently working at railhead had also to be supplied with water. In addition to this the 3,000 men had to be fed, and every day one mile of rails and 2,000 sleepers had also to be brought out. Then again, precautions had to be taken against the possibility of a breakdown, for had this occurred, the railway battalion would have been cut off from their water, and the lack of water in the desert means death. This stern fact accounted for the ponderous iron

tanks, which were the most remarkable features of the train which conveyed us into the desert. We correspondents were particularly fortunate on this occasion, for we had as travelling companion Lieut. Girouard, R.E., D.S.O., the director of the Soudan Military Railway (this brilliant young officer has since been promoted to the rank of Major in the Royal Engineers, and he is now the Director of Egyptian Railways, with a salary of £2,000 a year).

We left Halfa in the afternoon, and early the next morning a long line of tents appeared upon the horizon. This was Railhead Camp, and here we left the train and were welcomed by the Sapper officers, who had prepared an excellent breakast. While the meal was in progress we gathered some interesting items with regard to the building of the railway. There are two railway battalions, made up of both Egyptians and Soudanese. They are civilians, bnt they receive soldier's pay and rations. Amongst them are a great number of Soudanese who were taken prisoners at Firket and Dongola in 1896. The black man is always light-hearted, and ready to laugh at any time and any place. Nothing seems to depress him, and no amount of toil to tire him. Imagine these men working out in the desert, a hundred miles from anywhere, month after month, from sunrise to sunset, in a choking cloud of dust, with the thermometer at 120° in the shade; yet in spite of all these adverse circumstances, the railhead gang was one of the merriest set of men in the world.

When the material train steamed into camp from the workings, the men scrambled out of the trucks laughing and chaffing and playing jokes upon one another like a lot of boys let out of school.

There was one very remarkable individual in the camp, called Samit. He was taken prisoner at Dongola, and he had fought against us at Hafir. He was a wonderful mimic and contortionist, and his *repertoire* consisted chiefly of imitations of the different Dervish leaders under whom he had served. Wad-el-Bishara was taken off by this savage comedian in the most beautiful manner. We saw how the Dervish leader crouched behind the fortifications and trembled with fear when our shells flew screaming over his head. But the most marvellous of all his performances was the rather gruesome imitation of a man being hanged. Samit in this was perfect and horrible. The protruding eyeballs, the spasmodic jerk of the limbs, the quivering tongue, all these were imitated with wonderful fidelity. The gestures of a special artist making rapid sketches did not escape the watchful eyes of Samit. It was not long after my arrival in the camp that he was seen on the top of a truck in an exaggerated posture sketching his comrades amidst roars of laughter.

By the time breakfast was over, the material train was loaded up with more rails and sleepers, and a start was made for the workings, about five miles out of camp, and here we saw exactly how the line was being built. The surveying party were on ahead, measuring, taking levels, and deciding the course of the railway. Behind them came the "bankers," who built a bank or dug a cutting, according to the nature of the ground. Then the material train arrived, creeping slowly along to the end of the rails already laid and there stopped. Immediately the workers jumped down from the trucks, and so admirably were they drilled that without any confusion the men at once fell into their appointed places. The first thing was to unload the sleepers and lay them down along the track in front of the engine. When this was done the rails followed, and were placed in position and held there temporarily by iron spikes. When a hundred yards or so were ready, the engine crept forward again, and halted only to disgorge more sleepers and more rails. It was a magnificent sight. We watched the work go on spellbound. The engine, the material train, and the workmen were enveloped in a cloud of sandy dust, every form became indistinct. Under the blazing tropical sun the component parts became merged into a fiery mass; it was no longer a machine and men working like machines: it was an irresistible monster taming the savage pitiless desert.

The construction of the Abu Hamed Railway was undoubtedly the chief feature of the campaign of 1897. It was vastly more important in its results than the battle of Abu Hamed, for without that railway the British flag would never have been hoisted at Khartoum on the 3rd of September last. The Khalifa's army, encumbered by an enormous transport, would still have been creeping slowly southwards along the Nile to Omdurman. Abu Hamed was bound to fall into our hands sooner or later, though that event came upon us as a surprise. The reason for General Hunter's sudden dash upon that place was the result of information brought to Merawi Camp by the friendly Arabs, to the effect that the Khalifa was sending troops from Berber to reinforce it. The strength of it

garrison was known to the Sirdar, so he decided to seize it before the reinforcements could arrive. With Abu Hamed taken, Berber became untenable to the Dervishes, who evacuated it, and retired upon Metemmeh.

With Abu Hamed taken, the Sirdar at once pushed on his troops to Berber, and occupied it, and when this important city fell into our hands, the whole question of the Soudan became much less complicated. By the fact of its falling, the Khalifa lost the use of a very powerful limb. The Eastern Soudan, where for so many years the wily Osman Digma reigned supreme, was no longer an element of menace to our advance, and the pacification of the tribes which inhabit the country between the Nile and the Red Sea became a very simple thing. The battle of Abu Hamed, and the occupation of Berber, took place before my colleagues and myself had reached Merawi, which was the point from whence the Sirdar struck this blow. There appeared to be no prospect of immediate fighting, and the great question in camp was whether a British expedition would be sent out or not. There was nothing for us to do but wait for further developments, so we proceeded to make ourselves as "comfortable as possible," which is a watchword of the Egyptian army in the Soudan. Our position, as war correspondents, was really an unenviable one. We had travelled nearly 4,000 miles from London to record the military operations of the Egyptian army, and the first thing we learnt on arrival at headquarters was that the fighting was all over for the present. For us there would be no riding immense distances with exciting news, no smoke and roar of battle, no moving pictures of an army on the march. We strove to attain unto the philosophy of the Orient, which enables a man to preserve his equanimity under the most adverse circumstances, to cast from his mind all troublesome and disquieting thoughts, to find eternal consolation in the utterance of that all-embracing word "Mahlesh," which means "It is a small thing," "It does not matter," "Do not worry about it," &c. &c. I cannot say that we succeeded greatly in our efforts to assume this sublime attitude—the intense heat and choking dust storms interfered too frequently with our labours—and life at Merawi would have been unendurable but for the genial and untiring hospitality which we received from the officers of the Egyptian army.

While there I made a very enjoyable expedition from the camp to the pyramids of Napata, which are situated on the opposite bank of the Nile. These pyramids lie clustered together on the western side of Gebel Barkal mountain, a huge mass of sandstone rock which rises majestically out of the desert. It was my great privilege to have as a companion on this occasion Dr. Wallis Budge, the Keeper of the Egyptian Section of the British Museum. He had been sent out by the Government to make excavations among these interesting and little-known relics of the past. His presence at Merawi was not officially made known; in fact, we correspondents were requested not to mention his name publicly, because the Sirdar had received so many applications from Egyptologists all over the world, asking for permission to excavate, a permission which it was impossible to grant them at that time. I learn that Dr. Budge is on the point of bringing out a book upon his discoveries at Merawi, therefore I feel myself at liberty to refer to him now. He and I had arranged to go on board our giasseh and cross the river at midday, but the "reis" and his crew did not put in an appearance until four o'clock in the afternoon. It was a good opportunity for the use of the word "Mahlesh," but I fear we expressed our feelings to the "reis" in more forcible English. This delay meant that we should not reach our destination until long after nightfall, because there was no wind for sailing, and the muddy waters of the Nile at this season of the year run down at the rate of eight miles an hour. The width of the river at Merawi is nearly a mile, and by the time we reached the opposite bank our boat had drifted a mile or more down stream. Then the crew got out and commenced to tow us up the river. It was a very tedious and slow means of progression, for every hundred yards or so we came across a "sakeyeh," one of those ponderous water-wheels which are so characteristic of the Nile, and which groan day and night while they feed the tall date palms and green dhurra fields around them. These pumps, though indispensable to cultivation, are an unmitigated nuisance to the river-side traffic, because the tree trunks which support them just out far into the deep water, and a lot of time is wasted in passing the tow rope round the outside of them. We negotiated thirty or forty of the sakeyehs before sunset, and the reis then came to say that he would not be able to bring us to our destination. The prospect of passing the night in his ramshackle boat did not appeal to us at all, so we told him we

would make it our business to get him dismissed from the Government service on our return to Merawi. (I should say that at that time every boat on the Nile between Halfa and Berber was impressed into the service for the transport of military stores.) This threat, coupled with that of "no backsheesh," had the desired effect, and he swam ashore to join his men at hauling the boat along; and about eight o'clock we reached Gebel Barkal, where we were carried ashore in the stalwart arms of the boatmen. We groped our way across some small fields and irrigation channels until we reached the Sheik's house in the village, where our quarters were to be. Here a frugal meal of sardines and bully beef awaited us, spread out beneath the palm trees; and when dinner was over, we retired to our "augureets" or native beds, for the night. It was so hot and close, that I got my servant to move the bed out into the open ground away from the trees.

The following morning I awoke to find myself in the centre of a small lake, with the water half way up the legs of the bed. It then dawned upon me that my augureet had been placed in a dhurra field, which the owner had commenced to irrigate during the night. There was nothing for it but to wade through the mud and water to dry land and finish my toilet surrounded by a laughing circle of Arabs and their wives. After breakfast, donkeys were brought round and Dr. Budge and I started for the pyramids. We rode for a mile or more over splendid soil that had once been cultivated, but which, under Dervish rule, had returned to its original desert state, and produced nothing but the poisonous Sodam apple. Here were thousands and thousands of acres of rich ground ready to yield two rich crops every year, if only the irrigation channels could once more be filled with water. But the owners of the soil had long since been looted of all their cattle and able-bodied men, and the result was desolation.

The pyramids are six in number and, with one exception, they are all in a wonderful perfect state of preservation. None of them, however, are of such vast dimensions as the pyramids of Gizeh; the largest does not exceed sixty feet in height. They appear to have been built in groups of three, placed at right angles to one another. The stones which form the outer facing are small, not more than 3 feet long by 1½ in depth, and they are not fitted closely to one another. In places where these have fallen away, one sees that the interior is built of small stones and rubble, indicating a late period in Egyptian history, and the decadence of its architecture. A gang of Arabs, who were employed by Dr. Budge, were sinking a shaft under the foundations of the central pyramid, where it was hoped that the passage would be found which communicates with the interior of the pyramid. Whilst watching these men digging away the earth and levering up huge blocks of stone, I began to feel the excitement of the explorer. History has no record that these ancient tombs have ever been opened, and who could tell what priceless treasures might be concealed beneath this mass of masonry, what rare inscriptions might adorn the walls of its sepulchral chambers?

Not far away from the pyramids stands the remains of the temples of Napata. The hand of time and man has turned with terrible effect against these glories of a departed age, and the place to-day is truly an "abomination of desolation." Here and there a sphinx's head, minus the nose or the chin, peeps at you round the corner of a carved and polished block of granite. Of the hundred or more columns which still raise their heads above this broad expanse of ruin, not more than two retain their capitals, and both are in a tottering condition. Quite close to them there is a small temple, carved out of the sheer up-cliff of Gebel Barkal. It contains three chambers, the central one being the largest, with two smaller ones on either side of it. In every case the walls are richly decorated with hieroglyphics, and in some places the original colouring remains. It is, however, extremely difficult to trace the details of the carvings, for the wild bees have found them convenient projections on which to build their little nests.

Gebel Barkal, as it is now called, was once the capital of Ethiopia. In the unsettled times which followed the death of Ramses II. the Ethiopians saw that the power of Egypt to retain her supremacy abroad was becoming less and less. For many years they paid the customary tribute to the feeble successors of Ramses, but at the same time they looked forward to the day when they could cast off the yoke of Egypt. They had adopted Egyptian civilisation, the hieroglyphic form of writing language, and also the religion of Egypt. They seemed to have wished to make a second Egypt in Ethiopia. During the reigns of the kings of the twenty-first and twenty-second dynasties the power of Egypt continued to decrease, and the Ethiopians boldly resolved to

found a kingdom of their own, and they chose Napata as the site of their capital. The founder of the kingdom was one of the descendants of the priest kings of the 21st dynasty. Early in the 8th century, B.C., Piauchi was king of Napata. In the 21st year of his reign he marched northwards and defeated the army of Tafuecht, Prince of Sais and Memphis, first at Thebes, then at Hermopolis, and finally at Memphis. The rebel princes came in one by one and tendered their submission to the Ethiopians, and thus Piauchi became master of Egypt. All this and more is written large in hieroglyphics on the rock walls of these ruined temples and the broken fragments of the columns which block up the entrance to them.

A few days after my visit to the pyramids permission arrived from the Sirdar for the correspondents to proceed to Berber, so we lost no time in striking our tents and bidding farewell to Merawi. We followed the line of march taken by General Hunter when he advanced on Abu Hamed, and we reached that place in ten days. There were no exciting incidents to break the monotony of this long march, one day was exactly like another, and with the exception of Hebba there was not a single place of interest to visit by the way. It will be remembered that it was at Hebba that Colonel Stewart and his companions came to an untimely end. He was sent down by Gordon from Khartoum in the steamer *Abbas*, with full details of that gallant man's desperate position. Through the treachery of the "reis," the steamer was run upon the rocks in a narrow channel of the rapids, where she stuck fast. Seeing that the boat was of no further use, Colonel Stewart and his party landed at Hebba, where they were received with every mark of hospitality by the Sheikh Fakri Wad Osman. He told them he would afford them all the aid he could, at the same time sending off a messenger to Sheikh Sulieman Wad Gamr to tell him to come with all his people, for he had the "infidels" at his mercy. Poor Stewart trusted his host, even so far as to enter his house unarmed, and when the reinforcements had arrived from Wad Gamr, there ensued a brutal butchery which only ended when all but the native interpreter had been cut to pieces. This is an outline of the tragedy of the Abbas, and it was not without a feeling of depression that we saw, as we gained the last eminence overlooking the river, the remains of the steamer lying wedged between the ugly rocks, a grim relic of a terrible disaster.

The people of Hebba belong to the Monasir tribe, which is well known throughout the Soudan for inhospitality. In travelling through their villages we had remarked upon their sullen demeanour towards us. They had been punished in 1885, for the murder of Stewart, by the River Column, under General Brackenbury, and a good many of their villages were destroyed. The present village of Hebba is immediately opposite to the island with the wrecked *Abbas* upon it. The channel was not more than 100 yards wide, but the water was broken and decidedly swift. However, a colleague and myself could not resist the opportunity of a closer inspection of the wreck, so we swam across. Our servants produced water-skins, which they inflated, and they tried to instruct us in the art of swimming with them, but they were so unsteady that we discarded them. The current was very swift, but by dint of hard swimming we got into the slack water at the tail of the island, and waded ashore. I put my sketch-book inside my helmet, and in this way carried it across without wetting t We found that there was very little left of the ill-fated steamer, when we got alongside of her; her peak stuck up out of the heavy sand, and the only thing wholly visible was her boiler, which seemed to be quite sound. Part of her bulwarks still remained, scored with many bullet marks, and the bulky pieces of her machinery lay half buried in the sand, but all the wood work and light iron had been carried away by the natives. We searched about for any relic that might remain, but found nothing, so we pluuged once again into the river, and regained the opposite bank.

We left Hebba the following morning and arrived at Abu Hamed two days later. Abu Hamed is only important now as being one of our victorious battle-fields in the Soudan. It is difficult to judge of what the place appeared formerly, since the greater part of it has been destroyed to make way for the new railway line which was only a few miles out in the desert when we passed through. It had been our intention to stay at Abu Hamed some days and rest our weary horses and camels, but finding that the Sirdar had taken up his residence at Berber, we determined to take the road again. Just before we left we were informed that a party of Dervish horsemen had swooped down upon the village of Abaddia, only seven miles north of Berber, and had killed and mutilated eleven of the inhabitants, at the same time carrying off a number of women and the Sirdar's mail, which happened to be halting there. An avenging force, consisting

of a company of the Camel Corps under Captain King, and Abdul Azzim Bey's Ababdeh irregulars, was sent out in pursuit, but the Dervishes did not wait to try conclusions, and in their haste to get away they dropped all their loot, including the mail bags. There was great excitement at Abu Hamed over this event, and the likelihood of our coming across a raiding party, added a zest to the journey. Our caravan numbered twenty-three persons, but all of us were armed, so we felt fairly confident of being able to resist any attack. However, we were not molested, and reached Berber without any exciting incident, making the 125 miles in five days. At Abu Dom, a small village at the head of the 5th Cataract, we halted for a few hours at mid-day, and the Sheikh showed us the boat in which Slatin Pasha crossed the Nile during his memorable escape from Omdurman. It was a curious ramshackle kind of craft, made of three baulks of hollowed-out palm trees, lashed together with bits of rope grass.

On arrival at Berber, after a thirty-five mile march, we reported ourselves at once to Colonel Wingate, the head of the Intelligence Department, and he did everything to make us comfortable. I shall never forget his kindness in sending us not only blankets and bedding, but his own cook and servants, and an excellent dinner to boot. The following morning we were presented to the Sirdar by Colonel Wingate. It would be superfluous on my part to give you at this time a description of Lord Kitchener, so I will merely say that he received us with that courtesy which is so characteristic of him. He told us frankly that the campaign was over, that he would not advance until the Nile rose again, and that he did not anticipate being attacked by the Dervishes. Under these circumstances he recommended us to return home, and he offered us the option of doing so either by the Abu Hamed railway, or across the desert to Suakim.* He told us that the latter route was practically safe for caravans, especially at that particular time, because General Hunter was away with a brigade scouring the country between Berber and the Atbara, and he would cut off any raiding bands of Dervish cavalry.

The prospect of the journey was a most fascinating one, and it is needless to say that we eagerly accepted this opportunity of seeing practically a new country, and of having the honour of opening the road from Berber to Suakim. The next few days were given up entirely to preparation for the journey. The difficulty of getting a guide was solved for us by Colonel Wingate, who gave us a fine-looking Bisbarin, named Osman, whose relatives in the old days had been "Sheikhs of the Post" between Suakim and Berber. We were deep in the bustle of preparation, when the arrival of Major Sparkes, commanding the 4th Egyptian Battalion from Suakim, with an armed patrol, aroused our keenest interest. His arrival was quite unexpected, and for us it was an added guarantee of the safety of the road. As soon as possibe I went off to see the first British officer who had crossed the desert since the rise of Mahdism. His information about the road was of the utmost value to us. We learnt from him one most important fact, which was that the wells at Obak afforded no water for camels, and this news was far from cheering. Obak lies about half way between Berber and Ariab Wells, distant 112 miles, and we had calculated on being able to water our camels there. There were wells six miles our of Berber, but that was all, and we had before us 106 miles to cover without water.

To those who have read the books of our boyhood, when the camel did all sorts of wonderful things, and kept a kind of reservoir of cool crystal water in one of his seven stomachs, the distance we had to travel seemed nothing, but the plain truth about it is that the camel cannot go for four days without water, unless he is trained for it beforehand. The camel has, first of all, to be deprived of water for two days, then for three, and the start must take place just after he has drunk enough for four. We, however, were obliged to start before this process could be gone through, so it was once more a case of "Mahlesh," and we decided to leave Berber on the 30th October, and trust to our luck. Our examination of the camels that were to convey us over the 245 miles of desert was not encouraging. There were 20 of them, all wretchedly thin, and covered with half-healed sores, and we cursed our guide, Osman, for supplying such useless looking animals. He only smiled an Oriental smile, and assured us that they were some of the finest examples of their race to be found in the Soudan, and that all of them were in wonderfully hard condition. For once he certainly spoke the truth, for there was not a soft lump of fat to be found on one of

* This journey from Berber to Suakim was described by Mr. Frederic Villiers, one of the party, in his paper read before the Foreign and Colonial Section of the Society, on the 18th January last.

them. However, the camels were there and we had to start, so we ordered him to put on the loads and proceed to Mahobeh Wells, where we would overtake him. Major Walter and the officers of the 9th Soudanese kindly gave us a farewell dinner, and about nine o'clock we mounted our camels and rode out of Berber, heading due east. Gradually the silver streak made by the moon across the hill became smaller and smaller, and finally disappeared altogether as we dipped down over a small ridge. Thenceforward we should see no welcome stretch of water until we came in sight of the dancing waves of the Red Sea. About eleven we arrived at Mahobeh, where our servants and the camels were waiting for us. Our original intention had been to start at daybreak the following morning, but in the East plans are made to be disarranged. We awoke to find the rest of the party, except ourselves, fast asleep, although we had given them orders to be ready at daybreak. A shout or two brought them all to their feet, and we ordered them at once to "shid," *i.e.*, load up. There was a look of astonishment on their faces. "But we must wait for Osman," they said. "Osman, why, isn't he here?" "Oh, no, he had not arrived from Berber yet." Our feelings with regard to Osman can be more easily imagined than described. Not content with getting us the most decrepit camels he could find, he had actually stayed behind, and was keeping the whole caravan waiting. "But why is he staying behind," we asked indignantly. "Ah! sir, he must say good-bye to his wife;" and this was all the answer we could get. However, we made them water the camels and get the loads ready. Most of the animals drank eagerly enough, but one of them absolutely refused to touch the water, so the camel man grasped it by the upper and lower lips and twisted them round like a pig's tail, while another man emptied three or four water skins down his throat. Amongst our animals we had two cow camels, with young ones running at their heels. One was about two months old, but the other was only seventeen days, and it was one of the prettiest creatures imaginable. It was covered with dark brown curly hair of great softness, and it kept frolicking around like a kitten. Towards the end of our long waterless march we noticed that the little fellow became very subdued, and showed every sign of great fatigue. By the time everything was ready for a start the sun was high in the heavens, and our guide, Osman, had not arrived. However, we had in our company two young Arabs, the sons of two Sheikhs of the region through which we should pass. Their fathers had been taken to Berber by Major Sparks, and were kept there by the Sirdar as hostages for our safety. The young men knew the way, so we set out upon our long ride across the desert, leaving word at the well for Osman to come and catch us up, which he did in the course of the day.

To describe the journey from Berber to Suakim in detail would be wearisome; the desert is always the same, no matter if you ride one mile or one hundred. Once embarked on this sea of sand, your only object is to get across it as quickly as possible. You know that there are wells at certain points, generally far apart, and your only anxiety is to find them. If you fail in this, you die of thirst, which is one of the most awful deaths in the world. These reflections were forced upon us when we reached Obak Wells. We saw that some of the camels were already beginning to feel the effects of two days without water. and the last half-day's march had been made through loose drifted sand, into which the camels' broad feet sank above the fetlocks. Obak Wells consisted of three little holes in the sand, and around each of these sat stolidly a group of women. These ghouls had filled up the holes with sand, and there was no chance of the water forcing its way through for a long time to come.

The people who inhabit the small patch of fertile land around the wells belong to the Bisharin tribe, and their Sheikh was with the Dervishes, and it was for this reason that we were unable to procure water. (Since our ride across the desert these and many other wells have been greatly improved and placed by the Sirdar in the hands of responsible people.) An inspection of our camels resulted in a decision to push on as rapidly as possible to Ariab, where we knew there was plenty of water, so we started the following morning at dawn. From Obak we commenced to draw upon our reserve of drinking water, which had assumed a dark brown inky colour, the result of being kept for three days in the half-cured goat skins. The taste of it also was terribly bitter, but we all had a thirst that made light of such trifles. We travelled as much as possible at night in order to save the camels, for under the burning rays of the mid-day sun they perspired freely. This night marching robbed us of our sleep, for it is too hot for a white man to sleep in the Soudan when the sun is up, but Ariab was two long

days' marches from Obak, and there was nothing else to be done. Washing was another necessity which had to be foregone, and the dirt accumulated thick upon our hands and faces. One of my colleagues' camel became utterly done up, and fell with him three or four times. Whenever this occurred it meant a considerable delay, for it was only after a lot of pushing, heaving, and beating that the wretched brute would hoist itself on to its legs again. Our last march into Ariab was 14½ hours without a single halt, and men and animals, thoroughly tired and worn out, lay down under the shade of a big mimosa tree near the deep well. A Hadendowa, a typical Fuzzy Wuzzy, was guarding it, with a spear in his hand and a shield slung over his shoulder. With a rope he let down a skin and filled it with deliciously cool and clean water.

We emptied that skin again and again. What a glorious drink it was! We all agreed that it was the very best we ever had in our lives. We halted at Ariab two days to rest camels, and we filled up the time by working at our note books and shooting gazelles, which were plentiful in the neighbourhood.

The remainder of the journey to Suakim was devoid of any such hardships as we had already endured. The flat desert we had hitherto passed over gave way to a mountainous country, and nearly all the "khors" in the valleys held water. This we obtained by scraping a hole in the shingley ground, into which the water percolated slowly. At Kokreb, two days march east of Ariab, we passed through what had been the toll-bar gate of the desert. At the foot of some rising ground was the abandoned camp of Osman Digma's brother, Abdullah Abu Bekr, who commanded a large force of Hadendowas. His duties were to collect the tolls from passing caravans, and send the money to the "Beil el Ual" at Omdurman. The place was well built, and surrounded by a zareba and palisade, and the interior remarkably clean for a Dervish dwelling. Near by was an immense graveyard, containing several hundred graves. It puzzled us to account for so many in this desolate country, and I can only suppose that the Hadendowas who were wounded in the fighting at Tamai and other places around Suakim crawled here to die, or were brought here for burial. We looked with interest at the various ranges of hills which we crossed over, because we were travelling over the route that would have been followed by the Berber Suakim Railway of 1884. When we saw the network of khors which run down from the western slope of the ranges towards the desert, we could well understand that that wild enterprise was doomed to failure, even had there been no dense hoards of fanatical foes to oppose its progress.

It was evident that at certain seasons of the year the rainfall in this district must be very heavy, for the mountain sides are scored with deep gulleys choked up with heavy boulders and *débris* brought down by the floods. My colleagues and myself were impressed with the difficulties that would attend the construction of a railway, and we wrote to that effect in our respective journals. I have since learned that prior to our ride across the desert a powerful syndicate had been formed in London to acquire powers for the prosecution of this project, but that, as a result of our observations, the scheme has been abandoned. I entirely applaud that decision, for although a railway could undoubtedly be built across that country, it would be a very costly undertaking, and it could not possibly be made to pay for many years to come. It must not be forgotten that the population of the Soudan has been enormously reduced of late years. With the death of General Gordon at Khartoum, in 1884, a period of bloodshed was inaugurated in that unhappy country, and it only ended on the 2nd September in this year, when the Sirdar's army slew 12,000 men. The Soudan was never a thickly populated country, and what little wealth it had was derived from agriculture. With a large proportion of its male population wiped out of existence, and the remainder reduced to beggary by the tyrannical rule of the Baggaras, whole tracts of land have gone out of cultivation. Under the most favourable circumstances, no return for money invested in the Soudan can be looked for for many years to come. The trade that exists to-day between Khartoum and Suakim is practically nothing, and the transport for the merchandise which passes between the two places is abundantly supplied by camel caravans.

The hilly country of which I was speaking just now, extends roughly for 120 miles inland from the Red Sea, and it is all very beautiful. The valleys are filled with dense vegetation, and every kind of game abounds in them. We saw large quantities of ariel, gazelle, hares, partridges, and sand grouse. A sportsman camped up amongst these hills would have no difficulty in making heavy bags. Our road lead over three mountain passes, the highest of

which was 2,800 feet. On the morning of our tenth day out from Berber, we reached Tambuk, the most advanced Egyptian post on the Suakim side of the desert. Here we found a well-built fort—the garrison of which has now been withdrawn—and two wells of beautifully clear water. We indulged in a shave and a brush-up—both very badly needed—prior to our entry into Suakim, and shortly after resuming the road, we gained our first glimpse of the sea. It was an intense joy to us to see a limitless expanse of water, after so many months of wandering in the parched and dried-up wastes of the Soudan. With my arrival at Suakim, the Soudan campaign of 1897 ended for me, for I received a telegram from *The Graphic* telling me to go the North-West Frontier of India. Thither I made my way as rapidly as possible, and arrived at Peshawur just in time to join Sir William Lockhart's column, and go with it into the Bazaar Valley. At the conclusion of that expedition I went over to the Malakand Field Force, and joined the division which was led by Sir Bindon Blood, through the Bumer country. The frontier fighting then ended, and I returned to England, *viâ* Bombay, where I spent a few days among the plague hospitals and segregation camps. I was unfortunately unable to reach the Soudan in time for the battle of the Atbara, which took place on Good Friday, and I remained in England until the end of June, when I set out again for Egypt.

A story is told of a war correspondent who was sent off to a campaign from London at such short notice, that his only equipment was the frock coat and top hat which he happened to be wearing at the time. Such a slender outfit might serve in some countries where a man can pick up things as he goes along, but a campaign in the Soudan is a serious business, and needs a deal of forethought and preparation. Every article of food, and every drop of drink, has to be taken up from Cairo to the front, and in quantities sufficient to last for three months at the least. Transport for oneself, servant, horses, and stores, is also another great difficulty, for with only one line of communication to an army more than 1,200 miles from Cairo, blocks on the way are only to be expected, and when they occur, the correspondent's turn comes last. The only thing one can do is to rush on as far and as fast as possible when the conditions are favourable, and trust to luck for the rest. From the war correspondent's point of view, there is no such happy hunting ground as the Soudan. Since the year 1895, a campaign in that country has been an annual affair. Although the Upper Nile cannot honestly be recommended as a summer resort, there are so many solid considerations to be set against the boiling heat, the choking dust, the tinned food, and the flies, that I have never yet heard of a man who refused the chance of going there. I think we correspondents have an infinitely better time of it than anyone else in the Soudan, because directly one campaign is over, we are hurried off to the North-West Frontier of India, Cuba, China, or elsewhere, and we return to the Nile just in time for the next. While we wander through fresh battlefields and countries new, the Egyptian army grills in the sun upon the ground it has won from the Dervishes, and waits patiently until the river rises and permits it to advance again and conquer fresh territory, but throughout each one of those weary months of waiting for the next fight, every officer and man in the force works hard, works patiently for the ends in view.

The result of each campaign has been that new provinces fall under the Sirdar's rule and have to be administered. There are also large populations to be governed—not after the manner of the Dervishes— and, above all, there is the great railroad to be extended southwards to the Cape. Vast possibilities hang upon the progress of this work, and to push it forward the rifle is laid aside and the pick and spade become the soldier's weapons. Never before has there been such a wonderful army, such perfect organisation, such mobility. In the summer it fights, ever victoriously, against a savage and a warlike foe, and the rest of the year it is busily employed in laying "permanent ways" across the sandy desert, fitting together locomotives and steam-boats, building hospitals, barracks, prisons, and resuscitating the trade of a once flourishing country. Already the strategic railway from Wady Halfa to Kermeh has developed into a going concern, commercially, and the day in not far distant when railway engines will be seen steaming in and out of Khartoum.

A few days after my arrival in Cairo a colleague and myself received permission from the Sirdar to proceed to the front, and the following morning we rose early to get our horses and sais sent off by the first freight train. Besides getting the stud entrained we had to see that the animals were all provided with seven days' rations. For four horses this amounted to a formidable pile of tibbin sacks, far too big

to be crammed into any English horse-box. But in Egypt the boxes are built differently, and gold letters on the outside of them inform you that they are called "animal trucks." The name is expressive and appropriate. They are not provided with swing-bars or partitions of any kind, and the consequence is that the horses get to fighting unless carefully looked after by the sais. In the present instance it was so, and just before the train started a terrible kicking and squealing arose inside the truck, and my grey horse was up on his hind legs biting viciously at his neighbour, who returned the compliment with his heels. Both the sais were hopelessly mixed up in the affair, and they had scarcely restored order when the train moved off, and we could only hope that none of them would be lame when they arrived at Berber.

We followed by the night mail which was filled with officers going to the front. What a striking scene that departure platform presents when the Sudan mail goes out. It is ill-lighted and crowded with people in tarboosh or turban, who apparently have no business there and perpetually get in one another's way. Uniform cases, portmanteaus, and camel-trunks are piled together in heaps, and dragged asunder again by gangs of swarthy porters, who yell and curse at one another, perspiring all the while. The individuals who own the luggage which causes all this commotion appear later on, dressed generally in grey flannel suits with tweed caps, looking very cool and very much like tourists. The tone of the proceedings is restored, however, by the presence of their friends, who come to see their comrades off in mess uniforms—both British and Egyptian. The final moment is marked by the ringing of bells, the blowing of penny trumpets, and the screech of the engine's whistle. Everyone is cheery as a schoolboy going home, and with many a jest and hearty hand-shake, the travellers clamber on board, and the train crawls out to the desert. How many splendid Englishmen have left Cairo by this night mail for the Soudan, never to return! The death-roll rises year by year, yet the old Nile still claims its victims, unappeased. Who can tell how many more will make their last bed beneath the palm-trees ere the autumn ends, and the river falls again, and the sand-banks reappear?

Such thoughts as these, no doubt, occur to many a man off to the front, but he leaves them behind with his dress-clothes in Cairo. The heat, the dust, and the other discomforts of the journey form a sufficient distraction to most people, for they take a deal of circumventing. As yet there are no Spiers and Pond refreshment rooms along the track, so if a man will slack his thirst with a cool drink he must look carefully after his lump of ice and soda-water bottles. It is really painful to him to watch the ice melt, and form an ever-growing puddle on the carriage floor. How he will want it to-morrow morning when he wakes up literally covered with mud formed of dust and his own perspiration, and his tongue cleaving to the roof of his mouth! As a rule there is nothing new or interesting to be got out of the journey to Assouan, but I was fortunate in having for my travelling companion an officer who was formerly in the police, and is now in the Sirdar's army at the front. At Bahana, a village north of Luxor, he pointed out a building in which a band of captured brigands were burned to death with petroleum some years ago. It was one of the dovecotes so common in this part of Egypt. They are square, and built of mud, and remind one of an Afridi tower. Clouds of pigeons inhabit them, and the yield of guano is very valuable. They are generally isolated buildings surrounded by a high wall, and desperate men could well defend themselves in one of them. Not long since brigandage was quite common in the provinces of Jirgeh and Kenneh, but a greatly improved police organisation has had its effect, and the bands have all been slaughtered, captured, or broken up, though isolated cases still occur from time to time. In due course we reached Shalal, where the railway terminates, and here we moved our baggage on board the Nile steam-boat leaving for Halfa. Shalal was a very important link in the long chain of communication with the front.

When we arrived there the first thing to arrest our attention was a deafening chorus of hammers ringing on the side of an iron barge propped up on piles by the river side. The barge was one of a fleet being built for the conveyance of "Mr. Atkins" to Omdurman or thereabouts. Each one was built in sections, fitted with a double deck, and carried 250 men. Speed of construction was the great thing necessary just then, and under Dragé Bey's able direction the little shipbuilding yard turned out one boat a week. We saw one launched, and a pretty sight it was. Steel rails, well greased, had been laid from the shop to the water's edge, and one after another the barges came rushing down in pieces, and plunged into the river with a tremendous

splash, reminding one of the water chute at Olympia. Directly one section reached the water half-naked men seized it and dragged it to one side to make room for its fellows, and two hours saw the barge bolted together, ready for the voyage to Wady Halfa. The temperature was 124° Fahr. in the shade, but everyone worked as if his life depended upon it. I watched the performance in the shade, but even then the perspiration dropped like tears upon my sketch-book. From sunrise to sunset this is the condition of life upon the Nile in summer time, and no one but a stranger pays any attention to it.

The ship-building yard of Shalal, filled with every modern appliance and machine, its background formed by the ancient temple of Philæ, afforded one of the most striking pictures on the Nile. From Shalal we travelled to Halfa by the post-boat, and without delay proceeded to Atbara camp by the now completed military railway. General Gatacre and Captain Cox, his A.D.C., were on board the train, and I was fortunate to get a place in the saloon carriage. Many of the trains which leave the great railway depot at Halfa are not provided with first-class carriages, or indeed with carriages of any kind, and the traveller has to content himself with an ordinary open truck. This, for a journey of forty odd hours across the desert, is not exactly a vehicle to enjoy oneself in, especially when the sun is up. Matting and canvas covers were made for the trucks, so that when the British brigade came up, the men were well under cover from the sun.

The train which I travelled by from Halfa left at one o'clock in the morning, and it was typical of the Soudan military railway. Next to the engine were placed three water trucks for the supply of steam, and for some of the desert stations there was one of the new iron boats from Shalal travelling in sections, and here were several thousand rounds of ammunition and sacks of corn, biscuit-boxes, and field hospital stores. Recruits and details of "Gippy" battalions stored themselves away in odd corners of the trucks trying to find comfortable sleeping places. Just before leaving the station, Lieut. Blakeney, R.E., the traffic manager, an officer to whom I am indebted for many kindnesses, and who has recently received the D.S.O. for his splendid services in the Soudan, came to tell me that my Soudanese servant Ahdul had been caught trying to smuggle through a boy, a relation of his, who wanted to go to Berber. The boy was carried off howling by a policeman. Every train has to be most carefully searched for stowaways, and no one is allowed to travel without a pass. There are eight railway stations between Halfa and Abu Hamed, and they are unique; they consist merely of a pass-by for trains and a signalman's hut built of sleepers, with a telephone wire passing through the roof. Nothing in the world could look more desolate, more forlorn, than these desert stations. By day they appear to be built in the middle of an island, and the rails to run north and south straight into a calm blue sea. The ever-changing mirage encircles them, the distant rocks and the telegraph poles dance and swing in the heat-waves. A remarkable feature about these desert stations is the little patch of fresh green "dhurra" (Indian corn) which the signalmen have raised in front of their cabins. The corn grows luxuriantly in the impossible-looking sand, and if only water could be procured in large quantities this ghastly desert could be transformed into a most rich corn country. Between Abu Hamed and Atbara the line follows the river banks for the most part, and passes several villages.

The natives look upon the engine as a sort of god, and stand in great awe of it. The sapper officers who built the lines have many amusing yarns to tell about their reception when first the locomotive came along. At Genannetti an Arab approached the officer in charge and asked him if his wife might creep under the engine. The reason for this extraordinary request was that the lady was anxious to have a child, so permission was at once given. Not content with crawling under the engine once, she asked if she might do it again, and her husband explained that this would ensure her having twins. A venerable sheikh, watching the railway battalion climb on to the long line of trucks, remonstrated with the officer in charge, saying that it was not fair to make the engine pull so many people at once.

Shortly after my arrival at Atbara camp I rode over one morning to Damali, 14 miles distant, where General Gatacre's British brigade was encamped. His force was divided, the Seaforths and Cameron Highlanders being quartered at Damali and the Lincolns and Warwicks at Es-sileur, a mile further north. The Sirdar, in his speech at the Mansion House, spoke in eulogistic terms of this magnificent brigade, and the invaluable services which they had rendered in the Soudan.

After the battle of Atbara this brigade was

brought here to await the final advance. Many people prophesied that this long period of inaction would be fatal to the health of British troops in the Soudan, and that these prophesies were not fulfilled was only due to the admirable arrangements made for their well-being by General Gatacre. With the exception of an epidemic of enteric fever, in which the Lincolns lost most heavily, there was practically no sickness. A certain number of men went down from time to time with ordinary fever, and it was found that the main cause of this was the chills caught by the men after bathing in the river. This practice was stopped, and covered baths were built away from the river, with the result that malaria disappeared. The greatest efforts were made to break the monotony of camp life, and supply the men with a certain amount of distraction. The most successful method and the most highly appreciated by the men was a river-trip down to Genannetti, a station at the head of the 5th Cataract. Two companies were embarked on barges and towed down by steamer to the head of the cataract, and after a visit of two days returned, the whole trip taking about a week. The squalid little village of Damali has become a great military station, possessing a theatre, a racecourse, a railway station, a street of shops and restaurants—at which none but teetotal drinks are obtainable—and an absolutely limitless parade-ground.

Damali has its graveyard, too, a small enclosure between the camp and the railway station. Within it lies exactly forty British soldiers who have died of wounds and sickness since the battle of Atbara. A high wall has been built round the graves to protect them from drifting sand, and when the troops leave for good the doorway will be closed up entirely. Everything within is plain and bare as the desert which surrounds it, but every grave is marked with a wooden cross, and several of them are adorned with some simple but pathetic tribute to the comrade who has gone. In some instances empty cartridge cases had been placed upon the grave in the form of a cross, with the initials of the deceased below it, while others were enclosed by a chain of rings formed out of telegraph wire.

The critical point in the campaign was reached when the Sirdar despatched the Soudanese and Egyptian troops from Fort Atbara to the advanced camp at Wad Habeshi, and filled up their places with the battalions which formed the new British Brigade. This was the moment when the great strain came upon the vast chain of communications which stretched from Cairo to Atbara; this was the time when every link of it was tested to the utmost. It was for this that the Sirdar, his staff, and all his transport and commissariat officers had worked incessantly through the killing heat of the summer. If a breakdown had occurred at any one point a tremendous block and serious delay would have resulted, and the whole plan of campaign would have been altered. But the chain did not break; every link of it held good; it was a perfect piece of workmanship. I witnessed the departure of General MacDonald's brigade from Fort Atbara, and it was one of the great sights of the campaign. The men fell in along the river bank, dressed only in their white linen shirt and drawers. A gun-boat, with a double decked iron barge lashed to either side of it, was in waiting, and at the word of command the men began to file on board two and two at a time. They swarmed over the gunboat and the barges, taking their places in long rows, and so closely packed were they that not an inch of deck was visible anywhere. The upper flooring of the barges bent visibly under the tremendous weight, and people on the bank wondered at the sight. An officer of high rank happened to be standing near me at the time, and I heard him remark that he thanked Providence the responsibility of the embarkation did not rest on his shoulders. A strong gale of wind was blowing at the time, the Nile flood was tearing down like a mill-race, and under the circumstances it was a daring thing to send off 1,200 men on a voyage of 100 miles in such a flimsy topheavy craft. I honestly believe that the Sirdar was the only man in the Egyptian Army who would have dared to do it. I know that great relief was felt when the news of their safe arrival reached Atbara.

Directly the Egyptian Army had gone south the British troops began to arrive. First came the Rifle Brigade, then the Guards, and they were followed by the 32nd Field Battery, the Howitzer Battery, two forty pounder guns, and the Royal Irish Rifles Maxim Battery. These were followed by the Northumberland Fusiliers, the 21st Lancers, and the Lancashire Fusiliers. The remarkable feature of the campaign was the way in which these battalions were brought to Atbara from Cairo. They arrived with a precision and regularity that would have been creditable to those responsible for their transport in England, but which in

that country was nothing less than wonderful. That the single line of railway which connects Halfa and Atbara should have been kept running without a hitch of any kind under the heavy strain of traffic speaks volumes for the watchfulness and forethought of the young sapper officers responsible for it.

The Sirdar gave the correspondents the option of going to Wad Habeshi either by land or water, so I decided to march with the 21st Lancers, who convoyed a large quantity of transport and an Egyptian horse battery along the left bank of the Nile. There is a great monotony and sameness about long marches in the Soudan; the present one was no exception to the rule, so I will only touch upon those points that possess the most interest.

The first two days were the most trying ones, for neither men nor horses were in condition, and it took some time for everyone to shake into their places. At Kitial, where we halted the second day, ten horses belonging to the 21st Lancers went lame with laminitis and had to be left behind. Their twelve days of continuous travelling up from Cairo had naturally prevented them from getting exercise, and the blood had accumulated in their feet. The result of this was that when they commenced to march across the desert the burning sand overheated the blood, and set set up fever in the feet. The remedy for laminitis is a simple one. These horses were left in the charge of an Arab, who kept them standing in the wet mud of the river bank, and in three or four days they recovered and followed after the column. It was at Kitial also that Private Bishop of the 21st Lancers died of sunstroke. His death was indicative of the intense keenness exhibited by every officer and man in this fine regiment to get to the front. Bishop was sick when he arrived at Atbara camp, but he refused to report himself, and managed to elude the doctor's eye until the column started. On arrival at Zaidal Island, our first halting place, the poor fellow was just able to lead his horse to water and then fell down unconscious. Surgeon-Major Pinches, who had such a narrow escape during the charge at Omdurman, made every effort to restore him, but without avail. He was stripped naked and laid on a waterproof sheet under the shade of a tree, and two comrades fanned him on either side with blankets while others poured cold water upon him. This treatment had the effect of reducing his temperature from 109 to normal, but from the first it was a hopeless case, and he died the following morning. Another touching incident of the march was the death of a British artilleryman at Magaweih. He fell from sunstroke fifteen miles from camp, and eight Egyptian gunners carried him that distance on a native bed. The party started at two in the morning, and reached Magaweih with their burden before the sun was hot. The loyal action of these Gippies is typical of the kindly feeling which existed between the coloured and the white men of the Sirdar's army. We marched over broad tracts of ground which at high tide is under water. Under the action of the sun this ground becomes fissured and cracked in all directions, and the progress of the column was considerably retarded, for the horses continually put their feet into the holes, and to avoid breaking their legs the men were ordered to dismount and lead them.

Wherever we camped we found these fissures infested with scorpions, and at one place I treated three of our servants who had been stung by them. The men were evidently suffering intense pain, and readily submitted to the rough and ready treatment. It consisted of making transverse incisions in the skin of the part affected, and thus produced bleeding, which was encouraged with vigorous squeezing. The wound was then washed and Scrubb's ammonia rubbed in. The remedy was not considered complete until the patient had swallowed a stiff mixture of brandy and water, and it is only fair to my treatment to say that the next morning these men were all alive, and declared themselves absolutely cured. Three days marching from Kitial brought us to the historic town of Metemmeh. Never shall I forget that place. It is a vast charnel house, and its 1,000 mud dwellings are filled with the bones of men and animals. They lie there to this day, the silent testimony of Dervish butchery. While yet many miles north of the city, we came across the carcases of men, camels, oxen, goats, and donkeys scattered in all directions. In many instances the bodies were quite intact, and to look at them one might have thought that they had not been dead a week. The natural characteristic of Metemmeh is a dense clump of palm trees near the river, which, in this flat and barren country, forms a landmark for miles around. The town itself lies about a thousand yards away from the Nile, and further back in the desert is the "dame" or camp to which Mahmoud retired during the

bombardment of last year. Colonel Martin halted the column in the palm grove for three hours, and I took the opportunity of riding through the town and the camp beyond it. There were carcasses lying everywhere, and in every attitude. As I passed through the deserted streets not a sound broke the death-like silence of the place. My horse snorted fretfully as he breathed the tainted atmosphere, and started aside with fright when we came unexpectedly upon some dead body lying in the roadway. The only living thing that I saw in Metemmeh was a large tarantula which ran across the street, a meet inhabitant of this city of the dead.

While on the march, we were quite isolated from the post and telegraph service, and it became necessary to establish a system of our own. We sent our letters and telegrams down the river by native swimmers, of whom there was no difficulty in finding. Our amateur postman hunted about the river bank until he found a suitable log, launched it, wrapped his one and only garment in a huge coil round his head, with the letters inside, and departed. He had sixty miles to go, and we gave him six shillings at starting and the promise of an equal amount upon arrival, and with these terms he was thoroughly contented. Innumerable khors run inland towards the desert, and they were rapidly filling with water from the rising tide. Here was presented the anomalous sight of streams running out of a river, and not into it. The filling up of these khors proved a considerable drawback to our march up from Atbara, frequently necessitating detours from the road. The ground for several feet on either side of the khors became saturated with the water, which turned it practically into a quicksand. This rendered it extremely difficult to water horses and camels, for it is only possible to find firm spots here and there. Indeed, the horses were so frightened of sinking in the mud, that as a rule they would not approach the water, though they were dying of thirst. When one, a little bolder than the rest, could be induced to approach, he did so most gingerly, and often put himself into the most extraordinary attitude for drinking.

In advancing to the attack on Omdurman, the Sirdar had the advantage of most complete and accurate information with regard to its defences. He knew every inch of ground he was going to fight on, the exact position of the fortifications and guns, and the best points upon which to develop his attack. It is not necessary to say that the greater part of this valuable information was supplied by Slatin Pasha. A soldier whose evil fortune compelled him to spend long years of captivity in his enemy's camp would naturally regard the defences of the place with an interested eye, and the splendid map—of which I was enabled to send home a sketch at that time—proved what advantage Slatin Pasha took of his position when the downfall of Omdurman took place; he must have at least had the satisfaction of knowing how largely he contributed to that great event.

The spies who constantly passed between the two camps kept the Intelligence Department informed of all that went on in the Khalifa's army, and their news was supplemented by deserters, who were numerous, especially since the battle of the Atbara. The Khalifa also employed spies, but they were perfectly well known at headquarters, and discreetly handled. They were supplied with false information, both with regard to the number of our troops and their movements. Through their medium the Khalifa learnt that the Egyptian army suffered terrific loss at the Atbara fight; that it was only advancing under compulsion, in great fear of the next battle, and so forth. He little knew that the only thing his enemy dreaded was the possibility of his running away, that such a calamity hung like a nightmare over our camp.

The confidence of the force in the probability of a fight was reassured by the events of the 31st August. On the afternoon of that day, the 21st Lancers made a reconnaisance up to Kererri, ten miles distant from Omdurman, where they came in touch with the Dervish cavalry. I happened to be present on the occasion, and saw Capt. Kenna and Lieut. the Hon. R. de Montmorency return from their scurry after the enemy in the bush, the former with a long Dervish spear in his hand. The news that the enemy in considerable numbers had been met with, spread like wildfire through the camp, and the next morning the whole force rose gaily from their slumbers, in spite of a drenching rain, confident that the weary months of waiting and the long marches would at last be rewarded by a battle. We left camp that morning in the formation that had been adhered to since the departure from Wad Hamed; that is to say, the 21st Lancers advanced along the river bank ahead of the infantry, and the Egyptian Cavalry and the Camel Corps on the right. I attached myself to the latter force, and gained from the top of

Kerreri Hill my first sight of Omdurman. It was a vast city; the first view of it staggered me. For miles and miles along the Nile bank stretched a dark mass of buildings, and from the centre of it rose a glittering dome—the Madhi's tomb. Little time, however, was devoted to looking at it through the binoculars.

Colonel Broadwood gave the word to advance, and the 2,000 men under his command moved off across the plain in a south-westerly direction. A mountain ridge, called Gebal Fareid, rises out of the desert, three miles due west of Omdurman. Towards these hills we made our way across swamp and wet sand into which the wheels of the field battery sank to their axles. It was terribly hard work on the horses, and the pace was slow in consequence, but Broadwood persevered, and about mid-day we halted at the foot of Gebal Fareid. There we dismounted, and scrambled up over the burning rocks to the top of it, eager for a nearer view of the city. For some moments there was absolute silence amongst the party — no one spoke. I confess that a feeling of awe took hold upon me. Omdurman lay at our feet; the mosques and the houses were plainly visible. Nothing that I had read or heard of it had ever conveyed an idea of its monstrous size. Then we began to look about for the enemy, and we soon saw them. A first glance at the city led one to believe that it was surrounded on the desert side by a wall or a zareba. But as we looked at it, this wall began to move, and gaps appeared in it, all at regular intervals. Then we saw that they were men, and that there were many of them. They were not bunched together in haphazard masses. They were formed up in regular brigades, and they were advancing. We could hear the deep-toned note of the ombeya, the Khalifa's war-horn, and we could hear our gunboats firing, and see the cloud of dust which their shells threw up when they burst. The distance between us and the enemy was rapidly diminishing. They were coming on very fast, and Colonel Broadwood, having thoroughly reconnoitered the position, gave the order to retire. The heat of the midday sun had considerably dried up the wet sand, and the guns and the camel corps made better progress over it; but even so the enemy were gaining upon us, and very shortly, after we had quitted Gebel Fareid, the Dervishes were upon it. It was a most interesting situation. We were six miles away from any support, and the whole of the Khalifa's army was within a mile of us. Once the bugles rang out and the squadrons wheeled round, ready for a charge, because a trooper has been dismounted, and it was feared that he might be cut off. The rear guard however, brought him in all right, and we turned again and reached the Sirdar's camp at Agaiga as the sun was sinking in the west. On this occasion Colonel Broadwood displayed some of the finest qualities of a cavalry officer, and conducted the reconnaisance in the most masterly manner. He took every advantage of the ground he had to cover; he waited until the enemy's strength could be accurately gauged, and he withdrew exactly at the right moment and in perfect order.

The events which happened on September 2nd crowded one upon another in quick succession. I do not think it would be ever possible to pass another day so filled with stirring incidents, so pregnant with historical events. The Sirdar's army was fighting and marching incessantly for sixteen hours, and it is quite beyond my powers to condense the day's work into the present paper. The battle of Omdurman is of such recent date, and the details of the fight have been presented to the public so exhaustively by the Press, that I venture to conclude this paper by merely showing and explaining the sketches which I made upon the battle-field.

DISCUSSION.

The CHAIRMAN said it was usual for the paper to be followed by a discussion, but on this occasion he did not know that there was much room for comment or criticism. He would, however, ask Mr. Thomas, of the *Graphic*, to say a word or two.

Mr. THOMAS said every one must have admired the plain, straightforward account which Mr. Maud had given them of the Soudan campaign. He had resisted any attempt at sensation, and had given a narrative which all must feel to be true. The principal thing which struck him was the remarkable way in which the drawings had borne enlargement. They were made as quite small sketches, and yet, as they appeared on the screen they looked as if they had been intended for cartoons, they were so admirably drawn.

The CHAIRMAN said:—I am sure you will all agree with me that we owe Mr. Maud our cordial thanks for the interesting paper which he has just read, and for the reproduction of the sketches made by himself. About a year ago, when war artists and correspondents were for some unknown reason not very popular in the Soudan or elsewhere, I ventured

in this room, as one who had myself seen active service in the field, and who had known what difficulties war correspondents had to encounter on active service, to bear my personal testimony to the arduous, and at the same time useful, character of their duties; and I have therefore, on my part, listened with no little satisfaction to a paper which gives so good, perhaps I ought to say so graphic, an idea of an energetic war artist's experiences, although related with characteristic modesty so far as his own deeds are concerned; and I feel sure that Mr. Maud will always look back with pride to the recollections of his seventh campaign within three years, and to services performed with credit to himself, with advantage to the public, and with the cordial approval of the enterprising journal which he has represented. As the paper itself is one that hardly admits of criticism or discussion, I have but little to say in regard to it, except to corroborate the lecturer's account of the splendid railway work carried out in the valley of the Nile by the young officers of the Royal Engineers, under the guidance of Lieutenant—now Major—Girouard, and to bear my personal testimony to the appreciation of the Home authorities of that work. It forms, indeed, an honourable episode in the history of the recent operations, and carries us on, almost like a fairy tale, to the not distant prospect of a railway terminus at Khartoum, with branch lines, it may be, to the Cape and other parts of Southern Africa! Although no Englishman can look back without pride and satisfaction upon the recent campaign in the Soudan, which has been so well organised, so well led, and so well carried out by both officers and men, I think we may, by degrees, now calm down from our overflowing enthusiasm and settle down to business, as Lord Kitchener wishes us to do, in the shape of taking some steps towards the education and civilisation of those who have recently been our enemies, and towards the restoration to prosperity of a country which has suffered so terribly from the tyranny of the Dervishes since our disastrous abandonment of it some fifteen years ago. Gordon was indeed terribly avenged on the day of Omdurman, when justice was meted out with dire effect on the Mahdi's relentless horde; and if we can now honour his memory by making Khartoum the centre of civilisation and prosperity, England may well rejoice at having wiped out a blot in her history, and at having once more asserted her position as one of the great Powers of the world, whose aim is peace and goodwill, while not brooking insult or barbarism in her onward progress.

Mr. Maud, in reply, after thanking the Chairman for his complimentary remarks, said he had that morning had an interview with the Sirdar just before his leaving for Egypt. He went to see him about the fund for the Gordon College at Khartoum, with regard to which the *Daily Graphic* had taken a prominent line. Lord Kitchener told him that he regretted very much that his time was so much taken up that he had not been able to write to the proprietors of the *Graphic* to thank them for their services in this matter, but he hoped that he would convey to them his thanks, which he had done. This might be a favourable opportunity for any one who had not already subscribed to rectify the omission, and some one was in attendance who would be happy to receive names. Lord Kitchener said he felt perfectly confident that the sum for which he had asked would be forthcoming, and he thought it was the duty of every one to help him to realise his wish.

The Chairman then proposed a cordial vote of thanks to Mr. Maud, which was carried unanimously.

Miscellaneous.

TEXTILE INDUSTRIES IN SPANISH AMERICA.

A report has recently been prepared by the United States Bureau of Foreign Commerce on the textile industries of South America and Mexico, and on the import trade in textiles into the various countries. In Mexico there existed, in 1896, 98 factories of cotton goods and 23 woollen factories, representing a value in machinery and buildings of about £2,610,000. There were employed 21,963 workpeople and 370,570 spindles, and 12,454 looms were in operation. The annual production was 3,890,300 pieces of ordinary white cotton, 2,077,825 pieces of cambrics, muslins, &c., 188,500 coverlets, and 322,975 carpets, rugs, &c. There is a large factory of jute at Orizaba. Imports into Mexico of textiles from Great Britain in 1896 were valued at £814,000; from Germany £142,000; France, £241,000; Belgium, £2,000; and United States, £122,000. As regards the United States of Colombia, the statement is made that in Cauca common cotton and woollen cloths are manufactured. In Cundimarca, Boyaca, Antioquia, and Bolivar some manufacture of textile is carried on. In Santander handkerchiefs, cotton counterpanes, table cloths, towels, hammocks, hemp sacks, &c., are made in large quantities. The imports of textiles in 1896 from Great Britain were valued at £1,041,000; from France, £287,000; and from the United States, £34,000. The imports of textiles into Venezuela, during the same year, were valued as follows:—From Great Britain £655,000, Germany £97,000, France £17,000, and the United States £140,000. There is no statement available as to local manufacture. In Brazil there are numerous cotton mills producing low grades of goods. Several are at Petropolis. The Cachœira factory in Alagoas which has been in operation three years, paid in the first year a dividend of 48 per cent.; in the second

year, 50 per cent.; and, in the third year, 40 per cent. It has 480 operatives, and produced in 1896, 122,783 pieces of cotton cloth. The machinery cost £14,000; the buildings for the factory, £8,000; the houses for operatives, £2,125; and various appurtenances, £700. The enterprise is protected by an export duty on raw cotton, and heavy import duty on cotton fabrics. In 1896 the imports of textile fabrics into Brazil from the United Kingdom were valued at £2,700,000. Into Uruguay the imports of textiles were valued as follows: — From Great Britain £814,000, Germany £176,000, France £86,000, Belgium £12,000, and the United States £36,000. There are no particulars as to local factories. In the Argentine Republic it is stated that the textile industries have scarcely a foothold. There is one large woollen factory in Buenos Ayres which turns out blankets, flannels, and cloth for soldiers' clothing; and there are several establishments for the production of knitted goods. The amount of woollen, cotton, and linen fabrics annually imported averages £6,000,000. In Paraguay the imports of textiles were as follows in 1896:—Great Britain, £3,481; Germany, £4,500; and none from the United States and France. The imports of textiles into Chile from Great Britain in 1896 were valued at nearly £1,200,000; from the United States, £136,000; Germany, £566,000; Belgium, £30,000; and from France, £243,000. There is no statement available as to local manufactures. As regards Bolivia, the imports of textiles *viâ* the custom-house of La Paz in 1895 were valued at £43,000; the imports of textiles *viâ* Mollenda, Peru, amounted to 377 tons, the value not being stated. The imports through Antofagasta, Chile, amounted to 2,820 tons. There are no details available respecting local textile industries. In Peru there are two cotton factories. The Peruvian Cotton Manufacturing Company at Vitarte has a capital of £130,000 and was founded in 1847. It manufactures ecru goods and has an output of 3,000,000 yards annnally. The Fabrica de Tejidos de Algodon is at Ica. The capital is £10,000, and it is also employed in making ecru goods. There are three wool factories. The Santa Catalina at Lima; the Lucre at Cuzco, and the Urcon in the department of Ancachs. The imports of textiles in 1896 from Great Britain were valued at £687,354; from Germany, £200,000; Belgium, £2,800; France, £12,700; and from the United States, £28,000. In Ecuador cotton cloths are made in private houses and small workshops. There is a small woollen mill at Chillo. The imports of textiles in 1896 were as follows:—From Great Britain, £284,000; Germany, £47,000; France, £1,400; and from the United States, £11,000.

INDUSTRIAL CONDITION OF THE NEW HEBRIDES.

In a recent report by the United States Commercial Agent at Nouméa, it is said to be generally understood there that the New Hebrides Islands are about to become a French possession. They were occupied by the French some ten years ago, but never officially. The entire trade of this fruitful group of islands (imports and exports), amounting to about £200,000 annually, has been hitherto in the hands of French and Australian syndicates. The trade is capable of considerable expansion, and the land is adapted to the cultivation of coffee, cacao, vanilla, tobacco, sugar, rubber, spices, and every kind of tropical and semi-tropical fruit. Land is given free to immigrants under certain conditions. The total area of the chain of islands known as the New Hebrides is 3,625,957 acres; the southernmost island of the group is about 1,565 miles from Sydney, Australia, and some 230 miles from Nouméa, New Caledonia. The soil, composed of the accumulation of the vegetable *débris* of many centuries, is of the greatest fertility, covered for the most part with a thick underbrush, which in places becomes a dense forest containing a great variety of trees adapted for cabinetwork, shipbuilding, &c., such as the kaori, rosewood, and banian. Wild ducks, black pigeons, doves, parrots, and a great variety of birds abound in the archipelago. The year may be divided into two seasons. During the five months from November to March inclusive it is very warm, and the islands are subject to typhoons; the months of April and October are cooler, and the intervening five months are of an agreeable temperature. The native population for the whole archipelago is estimated at about 60,000 Canaques, widely scattered. They are savage and treacherous in character, but they will not attack foreigners if they see that they are armed or capable of defending themselves. Upon these natives the European planters, mostly French and English, and numbering about 200, must depend for their workmen. There are few real European settlements except in the Island Vaté, where at Port Vila there is a French colony of about 100 inhabitants, including women and children. At Undine Bay, in the same island, there is a small English colony. Here is the most important station of a French society, comprising a large coffee plantation with 20,000 trees, a banana plantation, and fields of maize and tobacco. This society also possesses an important station at Port Havannah, in Vaté, and others at Port Sandwich, Api, and on the canal of Segond. To every immigrant possessing a capital of 4,000 francs (£160), the society gives 25 hectares (62 acres) of land. It is stated that the New Hebrides can undoubtedly be developed; spices, and all tropical fruits yield abundantly; as well as vegetables, beans, turnips, carrots, cabbage, pumpkins, asparagus, radishes, &c.: the only exceptions are cauliflowers, artichokes, and potatoes. Yams, which yield well, are substituted for the latter. The tobacco is of excellent quality. It is sown in rows like turnips, but before sowing, a good fire of brushwood is made to rid the soil of the parasitic enemies of the plant. At the end of three or four weeks the seedlings are transplanted. In

a good year two or three harvests can be obtained. The cultivation of coffee is remunerative, though not so profitable as that of tobacco, on account of the expense of manual labour. The coffee of the New Hebrides is similar to that of Caledonia; the kernels are smaller, but have a very fine aroma. A coffee plantation commences to yield in the third year, but it is not in full production until the end of five years. In 1895, 100 tons of coffee were exported; in 1896, more than 150 tons. Many planters manufacture copra with the cocoanuts, which they buy from the natives. It takes about 8,000 cocoanuts to make a ton of copra. About 160 cocoa trees can be planted to the acre. The cultivation of the banana is very easy, and it has assumed large proportions in the last few years; from 10,000 to 12,000 bunches a month are exported to Sydney, where they have a ready sale at from one shilling and sixpence to three shillings the bunch.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at 8 o'clock:—

DECEMBER 14.—"Commercial Education." By SIR ALBERT ROLLIT, LL.D., M.P.

Papers for meetings after Christmas:—

"Tuberculosis in Animals." By W. HUNTING.

"Canals and Inland Navigation in the United Kingdom." By L. F. VERNON-HARCOURT, M.A.

"Preservation of Timber." By S. B. BOULTON.

"Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

"Leadless Glazes." By WILTON P. RIX.

"London Water Supply." By WALTER HUNTER, M.Inst.C.E.

"Maiolica." By W. BURTON.

"Wrought Iron Signs." By J. STARKIE GARDNER.

"Vitreous Enamels." By CYRIL DAVENPORT.

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

PROF. VIVIAN B. LEWES, "Acetylene." Four Lectures.

LECTURE IV.—DECEMBER 12.

The combustion of acetylene—Acetylene burners—Smoking and carbonising of burners—Burners for heating—Acetylene for gas engines—Diluted Acetylene and its applications.

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

January 16, 23, 30, February 6.

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

February 20, 27, March 6, 13.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian Lewes, "Acetylene." (Lecture IV.)

Imperial Institute, South Kensington, 8½ p.m. Major W. Beevor, "The Last Indian Frontier War."

Surveyors, Savoy-street, W.C., 8 p.m. Mr. Wm. Weaver, "The London Building Act and the Official Supervision of Buildings."

Cleveland Institute of Engineers, Middlesbro', 7½ p.m.

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Charles Stewart, "Life Histories of Some Plants and Animals."

TUESDAY, DEC. 13...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by Mr. Francis Fox, "The Ventilation of Tunnels and Buildings."

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5½ p.m. Annual Address by the President, the Rt. Hon. Leonard H. Courtney, "An Experiment on Commercial Expansion."

Photographic, 12, Hanover-square, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr F. E. Beddard, "The Cerebral Convolutions of the Gorilla." 2. Mr. H. H. Brindley, "Certain Characters of Reproduced Appendages in Anthropoda, and particularly in the *Blattidæ*." 3. Mr W. P. Pycraft, "Contributions to the Osteology of Birds." (Part. II.—Impennes.)

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m

Asiatic, 22, Albemarle-street, W., 4 p.m.

WEDNESDAY, DEC. 14...SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. Sir Albert Rollit, "Commercial Education."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m Dr. Edward F. Willoughby, "Some Prevalent Fallacies in Vital Statistics."

Royal Literary Fund, 7, Adelphi-terrace, W.C. 3 p.m.

Royal Society of Literature, 20, Hanover-square W., 1 p.m.

THURSDAY, DEC. 15...Royal, Burlington-house, W., 4½ p.m

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m 1. Mr. H J. Elwes, "Sketch of the Zoology and Botany of the Altai Mountains." 2. Mr. Thos. Scott, "A Description of some Marine and Freshwater Crustacea from Franz-Josef Land, collected by W. S. Bruce of the Jackson-Harmsworth Expedition."

Chemical, Burlington-house, W., 8 p.m. 1. Prof A. W. Crossley, "The Interaction of Ethyl Sodiomalonate and Mesityl Oxide." 2. Dr. F. S. Kipping, "Derivatives of Camphoric Acid." (Part III.) 3. Mr. W. H. Perkin, jun., and Dr. J. F. Thorpe "Synthesis of $\alpha\beta\beta$ trimethylglutaric acid."

London Institution, Finsbury-circus, E.C., 6 p.m Rev. Prof. J. P. Mahaffy, "Pitfalls in Education."

Electrical Engineers, 25, Great George-street, S.W. 8 p.m.

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, DEC. 16...Civil Engineers, 25, Great George-street S.W., 8 p.m. (Students' Meeting.) Mr. W. Daniel "The Kentish Town Widening, Midland Railway."

Quekett Microscopical Club, 20, Hanover-square W.C., 8 p.m.

Journal of the Society of Arts.

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FRIDAY, DECEMBER 16, 1898.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, 1899, at 7 o'clock, by Professor F. Jeffrey Bell, M.A. (of the Department of Zoology, British Museum). The first lecture will be on "Hands and Feet," and the second lecture on "Some Ways in which Animals Breathe." The lectures will be fully illustrated with lantern slides.

The lectures will commence at 7 o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each member is entitled to a ticket admitting two children and an adult. Members requiring these tickets should apply at once.

CANTOR LECTURES.

Professor Vivian B. Lewes delivered the fourth and last lecture of his course on "Acetylene," on Monday evening, 12th inst.,

On the motion of the Chairman a vote of thanks to the lecturer was passed.

The first lecture will be published in next week's number of the *Journal.*

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

December 6, 1898; The Right Hon. Sir Richard Temple, Bart., G.C.S.I., C.I.E., in the chair.

The Chairman said he had the very pleasant duty to perform of introducing his friend, Mr. Little, who would read a paper on what was one of the most important questions in the British Empire, viz., the circumstances attending the Yangtse Valley. This valley, from end to end, was the coming Empire—the British share of China and the sphere of influence. Mr. Little, who was the highest living authority upon the subject, had helped to navigate the river; he had dwelt on its banks and had traded in the districts along its basin. The paper, would be illustrated by a series of lantern slides taken from photographs by Mrs. Little, who would explain the different illustrations.

The paper read was—

THE YANGTSE BASIN AND THE BRITISH SPHERE.

By Archibald Little, F.R.G.S.

When approaching the coast of China from the sea at any point north of latitude 29° and up to the Gulf of Pechili in latitude 40° one is apt to run suddenly from out the deep blue waters of the ocean on to what has every appearance of being a hard yellow sandbank. At certain stages of the tides, the line of demarcation between the salt sea and the silt-charged brackish waters of the estuary of the great river, is as sharp cut as between sea and shore anywhere along our own coasts; and, but that one has full confidence in her commander, it is alarming to see the steamer running fifteen knots an hour full tilt upon the land, such as the thick yellow water appears to the eye when seen in contrast with the transparent azure of the surrounding sea. This mass of muddy water discharged by the Yangtse from its mouth near Shanghai has given the name of the Yellow Sea to the waters of the Pacific Ocean that wash the shores of China to the north of the Formosa Channel; while farther north again, and cut off from the

Yellow Sea proper by the projecting arm of the Shantung peninsula, lies the Gulf of Pechili, the depository of the similarly silt-laden waters of the Yellow River and of the Pei Ho in the north, whose combined deposits are fast filling up the basin, rendering, by the ever increasing sandbanks, the approach to Tientsin and the northern ports yearly more difficult to our steamers, and threatening, in the very distant future, entirely to close the "gulfports" of China to water communication.

That which the Yellow River is doing in the Gulf, the Yangtse is effecting along the coast of North China on a much greater scale. The sea that surrounds the Chusan Archipelago, a group of high rocky islands situated about one hundred miles south of Shanghai—the rendezvous of our fleets in the first Chinese war—is being rapidly filled up, the channels and harbours as delineated in the Admiralty charts drawn at that time being now scarcely recognisable. At the time of low water and at the season of spring tides, looking down upon the sea from a height on shore, the eye roams over an endless expanse of brown mud-flats, through which meander narrow river-like channels of muddy water; nearer Shanghai, and at the mouth of the river proper, the summer freshets of the Yangtse have built up wide flats, now embanked and cultivated, in reaches where the writer sailed freely thirty years ago. The great river is yearly extending its banks seawards and the time is not far distant, geologically speaking, when the islands of the Archipelago, now out of sight of the actual mouth, will be seen to stand forth abruptly out of a sea of paddy fields, as do to-day the isolated hills that here and there break the monotonous level of the great alluvial plain that surrounds Shanghai. And this is not astonishing if the estimate be correct that the Yangtse each year brings down no less than 267,000,000 cubic yards of soil, which is equal to the building up of an island one mile square and ninety feet in depth in the estuary each year. The great mountains of Tibet are being slowly worn away and cast into the sea, and the process is visible in the huge landslides and rock avalanches that suddenly fall across the valley paths on the Tibetan border in the monsoon season and often impede the progress of the traveller in that region for many days. I have myself had to halt a couple of days in the valley of the Tung, on the highway to Tibet, while a new rough path was being made, before it was possible to scramble over the pile of huge rocks that blocked the valley, the top of a mountain having broken off and come down in the night, the jagged cone whence the fall originated having every appearance of an extinct volcano. These rock-masses, gradually broken up and triturated by the roaring torrents that here go to form the many sources of the Yangtse, are farther on gently borne on the comparatively tranquil bosom of the Lower River and imperceptibly deposited in the shape of fine particles of sand and loam throughout the wide area of the estuary.

The Yangtse is one of the four great rivers of the world; it is the longest and, in the number of its affluents, the most far-reaching of the many streams that drain the vast Eurasian continent. It is to Eastern Asia what the Amazons are to South America, the Mississippi to North America, and the Nile and the Congo to the continent of Africa. Of all these rivers the Yangtse is that which has the greatest fall in its bed and the swiftest current, as becomes a river taking its rise in the roof of the world, and in this respect standing in marked contrast with the great American rivers, the Mississippi and the Amazons. It is interesting to note here that the name Yangtse is practically unknown to the Chinese; it is an old book-name for a short stretch of the river flowing through the district of Yang and past the modern treaty port of Chinkiang situated 150 miles above the mouth, but no Chinaman to-day would understand your meaning if you were to speak to him of the river Yangtse. In Chinese maps it is called the Chang Kiang or Long River and in ordinary conversation the Ta Kiang or Great River, or simply the Kiang, the river *par excellence*, as distinguished from the Ho the river of the North, an abbreviation for Hoang Ho, the Yellow River, that flows through that region. English geographers have, for convenience, given the name of Yangtse to the whole length of the river, and this old local name of a small portion only is fast becoming the world name for the whole extent of the stream, although it is unacknowledged by French geographers, who still call it the Fleuve Bleu, in contradistinction to the other great river of China, the Fleuve Jaune, or Yellow River. Both rivers have their sources in the Kwên-lun range in Northern Tibet, the ultimate source of each being within a few miles of the other. At starting, one river flows north and one flows south, though both ultimately pursue a western course in parallel lines to the Pacific.

The highest point on the Upper Yangtse,

where it traverses the Tibetan plateau before descending into the Red Basin of Szechuan, and thence onwards through the Hupeh gorges to its delta in Kiangsu, that has been scientifically determined, is in latitude 34° 43′ north and longitude 94° 48′ east: Shanghai, at the mouth, being situated in latitude 31° north and longitude 122° east. Colonel Prjevalsky, in 1873, found the altitude at this spot to be 13,150 feet above sea-level, and at this distance of 2,800 miles from its mouth, he found the river impassable, and speaks of it as a rapid torrent fordable in autumn after the floods have gone down, but only in a few places, with an average depth of 5 to 7 feet, and a width near the confluence of the Murui-usu with the Napchitai of 750 feet; but the whole river-bed from bank to bank was upwards of a mile wide, and, so his guide assured him, this was entirely covered during the rainy season in summer, when the river sometimes overflows its banks. Later, in 1879, the same indefatigable traveller followed up one of the affluents of the Murui-usu (the name given to the Upper Yangtse by the Mongols), almost to its source in the Tang-la mountains at a height of 16,400 feet, in latitude 33° 50′ and longitude 92° 20′.

This branch, the westernmost of all, and the farthest in distance of the many streams that go to form the navigable Yangtse, is commonly known as the Kin-sha Kiang, or Gold-sand River. Running parallel with the Kin-sha, and to the east of it, is the next largest stream —the Yalung. This branch takes its rise not far south of the Dring Nor, the lake in which the Yellow River has its source, the two basins being here separated by the Baian Kara range. The two streams flow in parallel ravines 60 to 100 miles apart, and run almost due south through seven degrees of latitude to their point of junction at the fork near the Yünnan border in 26° north latitude. The united streams here turn north-east and continue to flow in magnificent gorges past the foot of the Sun-bridge mountains, 15,000 feet high, the home of the independent Lolo, a distance of some 100 miles, to the city of Sui-fu. Sui-fu is an important distributing centre, and the first large city washed by the waters of the Yangtse after it issues from its fastnesses in Thibet. This city is built on high ground at the confluence of the Yangtse River proper, and its great affluent, the Min, which here joins it from the North. It is indicative of the fact that the Gold-sand River only becomes practically navigable after its confluence with the Min, that the inhabitants of Sui-fu, with the disregard of accuracy, combined with practical knowledge characteristic of the Chinese, here designate the Min as the "Great River," and the Kin-sha as the "Small River." The Min appears from ancient times to have been regarded by the Chinese as the main stream, owing to the fact of its being navigable and flowing through a fertile, populous country, while the Kin-sha drains a wild, valueless mountain region still almost totally unexplored. Thus, in describing the Yangtse basin and the British sphere, so-called, we shall not err if we follow the Chinese in treating the Min River as the real head of the Yangtse region and this we propose to illustrate with our lantern slides to-night.

In the autumn of last year I had the good fortune to follow up the Min River to one of its sources on the edge of the Tibetan plateau, to a place called Djang-la, a day's journey north of the Chinese frontier fortress of Sung-p'an Ting; I say good fortune advisedly, because any European who can escape from the damp, hot-house heat of the windless Red Basin, and pass through the snowy range, up into the dry bracing air of the Tibetan plateau, is to be esteemed fortunate. For this lofty range arrests the monsoon clouds from the warm China Sea which bank up against the snowy mountains, not unlike the cloud curtain over the Terai in India, hung up against the Himalaya. On this grand plateau, I, like others, have found restored health and activity, and am confirmed in my estimate of its beneficent climate by the splendid contrast its inhabitants present in physique and good looks, to the pale, dyspeptic Chinese of the lower Szechuan basin. Although the true source of the Min, judged by length of flow, is nearly 100 miles to the North-West, yet, at the time of my visit in October, 1897, the Djang-la stream provided the larger body of water. This stream has its source in nine springs of warm water — so the natives call it, although the temperature was only about 50° Fahr.—which bubble forth out of a valley to the North, bordered by low hills of limestone, a temple marking the sacred spot. Away to the North-East dividing the plateau from the basin of Szechuan, rise the magnificent snowy peaks of the Shüeh-pao-ting, apparently 22,000 to 24,000 feet in height, and the springs at Djang-la probably have here their source, and flow thence in underground channels until they spring to the surface at 11,000 feet above sea-level. Be this as it may, the water

is undoubtedly warmed by its passage through the ground, and never freezes in the coldest winters. These springs unite to form a good-sized stream, which flows in a rapid current of deep, pellucid water, through the centre of the main street of the little village of Djang-la, where its channel is lined with wooden walls and crossed by numerous wooden bridges. A short distance below it joins the Sung-p'an river, as it is locally called, in reality the Min, which flows hence in a deep ravine for a distance of 200 miles and more until at Kwan Hien, the "barrier city," it debouches into the famous Chêng-tu plateau and spreads out in many channels which ultimately reunite in the navigable Min, a short distance below the walls of the provincial capital Chêng-tu; these walls are defended by the wide swift-flowing streams of the upper Min, which form together a magnificent city moat surrounding this, the viceregal seat and busy metropolis of the vast province of Szechuan. Here navigation properly begins, at a distance, by the river's course, of 2,000 miles from the sea coast. Flat-bottomed boats, drawing under two feet of water, come up to the still-existing bridge of Marco Polo, outside the West Gate of the capital where, in the 13th century A.D., the Great Khan had his "Commercy" or Customs, which brought him in 1,000 gold pieces a day. These boats carry down the surplus produce of the rich Chêng-tu plateau, as well as the mountain products of the neighbouring Tibetan border: rhubarb, sheep, wool, musk, and skins. One hundred miles lower down a transhipment takes place into larger boats, which convey the goods 300 miles farther down stream—delayed at many likin stations on the way—to the treaty port of Chungking, the great distributing city of Western China, and future centre of its railway and navigation systems. Here the goods come under the tender mercies of the Imperial Maritime Customs, or the Foreign Customs, as they are generally called, and are sent on by junk again down river, the 500 miles of rapids and gorges which lead to the present head of steam navigation, Ichang. At Chungking, the Yangtse has already grown into a large, navigable river. In the summer flood season, the Yangtse at Chungking may be compared to the St. Lawrence, at Quebec, the Charles River there being precisely analogous in position to the Kialing River in Szechuan, that great affluent from the North, which unites with the Yangtse under the walls of Chungking; that city, like its Canadian analogue, being built on a high rocky peninsula formed by the here nearly parallel courses of the two rivers. The city of Chungking presents a remarkable resemblance to Quebec in outline, although in detail the contrast is as great as that between the East and the West generally. Chungking is far the more populous; including the sister city of Kiang-peh (*i.e.*, North of the Kiang), and the suburbs on the east bank, the population is estimated at from 400,000 to 500,000, and, being crowded upon a narrow, inelastic tongue of land, its inhabitants are pinched for room, and the handsome streets of the business quarter are as crowded as those of Canton. It is a luxurious city, and contains an unusual number of beautiful buildings, stately guild-halls, belonging to the different groups of traders from all provinces of the empire; as well as the gorgeously-decorated residences of the wealthy merchants and bankers. The people generally are well, not to say handsomely dressed; an air of marked prosperity and wealth pervades the place, and although there is much poverty among the coolie class, whose scanty wages only allow them to live from hand to mouth, this poverty is mitigated by the free rice kitchens which are kept open to all throughout the winter, and whose expenses are liberally met by subscriptions from the well-to-do classes. The severest suffering to the poor is caused by the great rise in the river in the rainy season, usually 80 or 90 feet above the winter level, and often, as was the case this past summer, to over 100 feet. Land being so valuable the poor risk building their houses outside the walls below the level of safety; then comes a sudden and unexpected rise, due generally to the flooding of the affluents above Chungking on the right or Yünnan bank, when whole villages are occasionally swept away and large numbers of people drowned in the floods. I have known the river rise as much as 25 feet in a single night. During the persistence of such a freshet all navigation is stopped; the broad river is converted into a roaring torrent with high breaking waves, and communication between the towns on the opposite shores is often stopped for days at a time by the ferry-boats being unable to cross. The river is then widened to over 600 yards and with a depth of forty to fifty fathoms; at the lowest winter level and at the narrowest point opposite Chungking its width is about 300 yards, with an average depth of 30 feet. Hence, the main traffic on the river is carried on in winter when tracking is comparatively easy: in summer the land route

mostly a succession of stone staircases which lead up and down the steep ranges into which the province is broken up, form the easiest and only safe route for the conveyance of passengers and merchandise throughout this populous country. These roads are thronged by porters and the main roads are lined with tea and rest-houses which depend upon this traffic for their custom. The cost of moving merchandise, which amounts roughly to one shilling per ton per mile, would seem to be a deterrent to all commercial intercourse; but so strong are the trading instincts of the Chinese that this is not the case and we find limited quantities of Manchester goods on sale even in Ta-li Fu, in Western Yunnan, which is mainly supplied from Chungking, although the carriage thither mounts up to £38 per ton.

Leaving Chungking, where we have made, I hope, no longer stop than its importance deserves, we descend a distance of nearly 300 miles, as measured by the windings of the river, and by a course almost due north-east, through the rich district known as "Tung Chuan," *i.e.*, Eastern Szechuan, to the flourishing city of Wan, likewise situated, as are all the chief towns up river from and including Hankow, on the north, or left bank. In this section of the river the rapids, though numerous, are short and easily negotiated, while the river flows through a more open, though still exclusively hilly, country rich in every variety of sub-tropical produce, of which the noxious, yet beneficent drug, opium, is not the least. Wan Hien itself is, like all the cities of China, surrounded by picturesque mediæval fortifications, pierced by imposing gateways. It is a smaller Chungking, a great junk-building centre, and home of rich junk-owners, and does a large trade in sugar and paper. This paper is made from macerated bamboo and is extraordinarily durable when compared with the miscellaneous productions of Europe. Indeed, the Chinese libraries of to-day stand a chance of being still in a good state of preservation when much of the doubtful paper of our 19th century literature will have inevitably decayed. As is to be expected amongst a literary people like the Chinese, the paper trade is a most important branch of general commerce. Apart from its business activity, Wan Hien is remarkable for its beautiful natural scenery, due to its being situated in the heart of a region of new red sandstone, with stratification almost perfectly horizontal, which has led to the cutting out of innumerable ravines with vertical walls, adorned with the abounding vegetation of a moist, warm climate, where frost is unknown. One curious rock in Wan Hien, known as the "Celestial City," rises abruptly 1,200 feet above the walls. The ascent is by a toilsome staircase cut in the rock face, the summit of which leads through a handsome archway into a small walled city, its lofty stone crenelated battlements crowning the precipice which surrounds this unique city on all sides. By my aneroid I made the height 1,235 feet, but I was more surprised to find the, possibly 30, acres of the flat summit covered with houses. There is a fine spring of fresh water and a pond never dry at the top, and the inhabitants are mainly well-to-do families who continue to live there on account of the greater security of the place in times of riot and rebellion. The Szechuan Chinese think no more of steps than do the Maltese. The view from this elevation is superb, but if I dilate on it, as I should enjoy doing, we shall not reach the sea to-night.

Soon after leaving Wan we enter a poorer country, where the rainfall is no longer regular as in Tung Chuan, and where, in consequence, of late years the unfortunate inhabitants have been a prey to an alternation of torrential rains and prolonged droughts. The excessive rains of September, 1896, produced the phenomenal landslip of Yünyang 50 miles lower down, which in one night narrowed the river from 600 to 150 yards, suddenly creating a new and dangerous rapid. I must not linger here, but I may perhaps be allowed to point out that you will find a detailed description of this remarkable earthquake—the site of which I visited while the disturbance was still examinable in all its original wildness—in a new edition of the "Yangtse Gorges," recently brought out by Sampson Low and Co. Another 50 miles brings us to the noted Szechuan frontier city of Kwei-chow Fu, or "Barrier of Kwei," once the seat of a flourishing customhouse or "grand commercy," as Ser Marco calls it, the mainstay of the viceregal revenue, now ruthlessly undermined by the imperious barbarians through transit passes, and sadly fallen from the high estate it held when I first visited the place fifteen years ago. Then its great water thoroughfare was alive at night with sounds of music and revelry, and its lively and more or less rowdy populace was a terror to the foreign traveller. Now famine and rebellion have added to its misfortunes, fiscal and other; the place has a quiet, decaying air, and its population is miserable. The changes which we call improvements are, even when necessary, often a very doubtful benefit to the people

more immediately concerned, and measures which our diplomacy wisely enforces produce great hardship through natural hesitation to carry our interference still farther and provide that "compensation for disturbance," which the Chinese officials themselves are helpless to bring about. Let us hope that the new era of railways and mining which has at last been inaugurated will provide employment for the people and an increase of income to the disturbed officials; for, as things now are, the Customs revenue is required to pay the interest on the cruel money indemnity—in addition to the cession of the rich island of Formosa—extorted by the Japanese after their successful war, in imitation of the bad precedent set by Germany in her settlement with France—*Væ Victis!*

A transparency of Kwei-kwan will enable you to form a good idea of the extent of the city, and of its position; while, as another slide shows the entrance to the magnificent Bellows Gorge, or, as it is well-named in the old Chinese gazetteer, the Gorge of the Fearsome Pool. This is the uppermost of the grand gorges, of which we have taken photographs; these, however, in the absence of colour, and with the difficulty of portraying their huge proportions in the limits of a camera, can only give you a faint idea of their real magnificence and the awe-inspiring impression which they make on the ascending traveller in his fragile barque. These grand gorges of the Yangtse are formed by the clefts which the river has slowly scooped out while cutting its way through the rugged mountain barrier, 100 miles in breadth, and 4,000 to 5,000 feet in height, which separates the two provinces of Hupeh and Szechuan, and which made of the latter in ancient times a kingdom apart—a happy Rasselas valley unknown to and undisturbed by the restless outside world. The rapids occur with great regularity in the broken intervals between the gorges; in spots where the clean-cut walls of these latter have broken down and dammed the stream, assisted by affluents in the shape of great mountain torrents on either shore that have cut out lateral ravines of their own and helped to block the main stream with the resultant *débris*. The clean-cut cliffs consist almost entirely of hard pure limestone built up largely of spiral ammonites and the straight orthoceras; these latter are often found embedded in a hard slate and are cut into sections and polished and then sold as pagoda stones, and are held in much esteem by the Chinese as a freak of nature imitating this sacred edifice of Buddhistic piety. On the other hand, where the river traverses granitic mountains, the rock is disintegrated by the water, and the river bank is composed of broken piles of gigantic boulders in lieu of the smooth cliff-walls of the gorges proper. In these latter the current is slow and the water astonishingly deep; with a lead line 150 feet in length I have often found no bottom, but I have never had the leisure to prosecute an accurate survey, and hence my figures are only approximate. Such a survey we trust our own Admiralty will shortly undertake, and its results must be of the greatest interest to geologists as well as to would-be navigators.

The last and lowest of the great gorges terminates five miles above the treaty port of Ichang, the present terminus of steam navigation. Here the alluvial plain begins, broken by mountain ranges athwart the stream, similar in character, but far less lofty and less continuous than those traversed by the gorges. From their flanks issue the great affluents from the South, two distinct and separate congeries of river net-works, each having an estuary of its own in the shape of a wide, shallow, inland lake, their combined waters more than doubling the volume of the Great River, below the point where the Szechuan waters, which we have hitherto been engaged in tracing, unite with those flowing forth from the Tungting and Poyang Lakes situated, the former 700 and the latter 450 miles from the Yangtse's mouth; between these two stands Hankow at the confluence of the Han and Yangtse. Hankow means Han-mouth and indicates its site. The Han is the great Northern affluent descending from the lofty Tsing-ling mountains which form the dividing range of the Yellow River valley from that of the Yangtse, and includes parts of the Northern provinces of Honan and Shensi in its watershed. From Ichang to the sea the river flows again through a fertile and populous country past towns innumerable, including three provincial capitals, of which two, Nganking and Nanking, are not yet open to foreign trade; and past five open treaty ports until the terminus of river navigation is at length reached in Shanghai, whence ocean lines radiate in all directions.

The Yangtse basin, of which the above is but a slight impressionist sketch—volumes would be needed to describe such an immense region in detail—comprises a watershed o

600,000 to 700,000 square miles [compare Great Britain with its area of 80,000 square miles] over one-third the area of China proper. It is one of the richest, if not the richest, sub-tropical region on the world's surface, and is inhabited by a people as hard working in their way as that of the United States of America, with which country it has so many points of analogy. The whole region, except the high pastoral plateau of the Tibetan portion of the catchment area, is cultivated like a garden: the mountains of Szechuan are terraced to their summits, and a ceaseless rotation of crops is forced from a willing soil by the repeated application of manure carefully garnered from the cesspools of the countless towns and villages which abound throughout this thickly-populated country. The vast mineral resources have hitherto lain practically undeveloped, but foreign methods and foreign capital will ere long do for these what Chinese hand labour has done for the surface soil, *i.e.*, develop mining; and so, with the additional aid of steam communication, enable China in time to rival Europe and America, certainly in wealth, possibly in power. The share that Britain is to take in this awakening of China to a development of her resources is vaguely indicated by what is commonly known as the British sphere. This sphere has so far, officially, neither been geographically described nor have its privileges or obligations been in any way defined. A Cabinet Minister did once speak of it indefinitely as the British sphere of interest, meaning thereby, apparently, that China's attempted alienation of this sphere to any other foreign power than ourselves would be regarded as an unfriendly act, and (such is the inference) lead to our forcible interference. But this has never been positively stated: the only official act is the letter of the Chinese Foreign Office on the subject, addressed to the British Minister in Peking on the 11th February of this year. This quotes Sir Claude MacDonald as saying "that the Chinese Government were aware of the great importance that has always been attached by Great Britain to the retention in Chinese possession of the Yangtse region, *now entirely hers*, as providing security for the free course and development of trade," and goes on to say that never shall territory in it be ceded to another Power.

Unfortunately the Chinese have no means to prevent such cession should it be forced upon them by an alien European Power. The whole crux of the position lies in the question—are we prepared to assist China to keep her promise? We can but give statesmen in this country the credit of understanding the situation, and being prepared, in the contingencies that spring out of the political weakness of the Chinese Empire, to act boldly as the best interests of this country demand. Meanwhile it is satisfactory to notice that the field is not being neglected by British capitalists, and that the lion's share of the work to be done, not alone in this special sphere, but throughout China generally, is falling into British hands, as befits those who have been mainly instrumental in opening up this wonderful and secluded country to the commerce of the world. In any case it is to be fervently hoped, as much in the interests of their own reputation as Christian Powers, as in the interest of the Chinese people, who, though with different ideas on the subject of patriotism, still love their country and their independence, that the nations of Europe will mutually agree to respect the integrity of this ancient empire. Harbours and fortified naval stations on the coast are now held by Britain, Russia, and Germany; it will be to the common advantage that the Hinterland of these posts of vantage should remain open as before, and it should, one would think, not be beyond the scope of an enlightened diplomacy to bring about common action to achieve a result so beneficial to all concerned.

At the conclusion of the paper, Mrs. Little described a number of lantern slides of the Upper Yangtse and beyond, which were shown on the screen.

DISCUSSION.

The CHAIRMAN, in proposing a vote of thanks to Mr. and Mrs. Little, said he had often presided at meetings of the Society, but he ventured to say that seldom, or never, had a more important paper been read, and a more valuable set of photographs exhibited within those classic walls. As might have been expected, the descriptions by the gentleman were the more scientific and more descriptive of important features, and those by the lady were the more graphic and beautiful. He should like to point out two great patriotic morals to be drawn from the paper and the photographs. As Mr. Little had spoken of the boundaries of the British sphere in the Yangtse Basin, he hoped that England would claim the whole of that sphere, the entire river, including that of Yangtse proper and the river of the Golden Sand, which was a continuation, with every affluent

and water-shed on the north and south. This, as they had been told, had not yet been delimited. There was a certain tone of complaint in Mr. Little's voice, as if he considered that England had not been quick enough, but it must not be forgotten that it was only since last March England took the matter in hand. Casting up results from that time, it would be seen that they had done pretty well. Further, Mr. Little said that one Cabinet Minister had been speaking of the sphere of British interests, but he had not gone beyond that. He (the Chairman) would point out that Cabinet Ministers were very apt to say what they thought Parliament demanded, and Parliament would demand that which the electors asked for. In the first place it was for experts like Mr. Little to explain the political and commercial aspect of the question to the electors, who in turn would make their voices heard in every great port and commercial centre of the British Isles, so that the magnitude of the interests concerned might become widely known, and it might be shown how vital these interests were to the livelihood of the working-classes in densely populated countries. If the electors of the country would do this they would accomplish a great deal, and in the long run it would be found that the House of Commons was the great centre of British patriotism. Further, he would recommend that the matter be brought before the Chambers of Commerce, who, when they found their interests were materially affected, would thunder at the gates of Cabinet Ministers. After that had been going on for a year or two, it would be found that Cabinet Ministers would speak quite as definitely as the country required. If they spoke indefinitely now it was because they were not quite sure as to the view of the nation, but, if the nation were prepared to make the sacrifice, the Cabinet would enter upon a truly patriotic and forward policy. No doubt the meeting was aware that, at present there was a railway which ran up from north to south; from Mandalay a railway had been sanctioned and was now in course of construction as far as the Ferry, where it stopped, because if it went further it would infringe on Chinese territory in the British sphere. It was for the electors of England to insist that the railway should be continued to the base of the Yangtse Plateau. When once they got to Talifoo, then the River of the Golden Sands was not very far off—and then they would get on to the navigable junction of the Min, and then to Mr. Little's sphere which he had won for the country by his commercial enterprise. When they got below the rapids they proceeded on to the Great Lake, and up that lake gunboats had been repeatedly taken from the Yangtse mouth in the rainy season. That was one way of asserting British supremacy in the Yangtse. What an imperial prospect would be opened out for British commerce! The day was not far distant when they would have a through line of communication from Rangoon in the Bay of Bengal to Shanghai, near the mouth of the Yangtse and the waters of the Pacific—a through line of more than 3,000 miles of British communication, with Siam and Cambodia, the Malacca Straits and Tonkin, on the right, and the mountains of Upper China on the left. This was a thing to work and fight for, and he insisted that these grand imperial interests, which formed the future of the trade of this country, would be promoted by means of the paper to which they had just listened.

The vote of thanks was then put and carried unanimously.

FIFTH ORDINARY MEETING.

Wednesday, December 14, 1898; Sir Philip Magnus in the chair.

The following candidates were proposed for election as members of the Society:—

Digby, William P., Valyevo, Wanstead-road, Bromley, Kent.
Laing, John Alexander, Rosendale, Stanstead-road, Forest-hill, S.E.
Hacking, Charles Leonard, The Gables, Nightingale-lane, Clapham-common, S.W.
Harries, David, Portland College, High-road, Chiswick, W.
Moriarty, Hon. Arthur S., I.C.S., care of Messrs. Grindlay, Groom and Co., Bombay.
Phillips, H. Fentum, Guildford Electrical Works, North-street, Guildford.

The following candidates were balloted for and duly elected members of the Society:—

Agnew, Sir William, Bart., 11, Great Stanhope-street, W.
Gardiner, Henry Nathaniel, 30, Finsbury-circus, E.C.
Gibb, George S., North Eastern Railway, York.
Hayles, George Edward, 12, Northampton-park, Canonbury, N.
Jacob, Augustus Hamilton, M.A., 26, Maberley-road, Upper Norwood, S.E.
Sears, Arthur Holroyd, Cae Glas, Llandrindod Wells, Radnorshire.
Townsend, John Walter, Wendreda, Lancaster-road, Wimbledon, S.W.
Walker, Arthur Tannett, Messrs. Tannett, Walker and Co., Leeds.

The paper read was—

COMMERCIAL EDUCATION.

By Sir Albert Rollit, M.P.

The subject of Commercial Education has become one of supreme and pressing importance, and having, as President of the London Chamber of Commerce and Chairman of its Commercial Education Committee, taken

an active interest in the question for some ten years, during which period it has attained its present prominence, I venture, in response to the request of your Council, and, I hope without undue presumption, to speak of it before your Society.

This reserve is due from me because, as a former Vice-President and member of the Council of the Society, I cannot forget that the Society of Arts, has for very many years promoted not only Technological, but also commercial, education by its examinations, formerly for its commercial certificate and since for proficiency in commercial subjects; while its Secretary, Sir Henry Trueman Wood, has also rendered great service at the Chamber of Commerce as a member of the Commercial Education Committee.

In this paper, I make no claim to originality, almost the most that can be said upon the subject having been already better said by others; what I seek to do is, rather, to summarise that which has already been accomplished,—and to make this a foundation from which to urge that further action which is so much needed in the interest of both the individual and the Nation, of commercialists and the community.

Moreover, I cannot claim to speak in any sense as an Educational Expert, like Sir Philip Magnus, but merely as a man of affairs.

From that practicul standpoint let me first ask what is the modern conception of education in what Shakespeare calls "This work-a-day world," in which men cry "live and let live," and which

> "Is a very good world to live in,
> To lend, or to spend, or to give in;
> But to beg, or to borrow, or get a man's own,
> The very worst world that ever was known."

But, whatever it is, we must make the best of it; and education is the art whereby we seek to enable our youth, individually and as members of society, to make the best and most of themselves, intellectually and physically, by the development of the faculties and potentialities which they inherently possess, and also by furnishing them with suitable and adequate knowledge.

Most educationists are agreed that in the "primary," or earliest stage of this process, the principal means should be, that the object, methods, and instruments should be not merely the loading of the memory, but formative, disciplinary, mind-making, with a view to the formation of character, and to that power and habit of good thinking which may readily apply or adapt itself to any subject; just as, physically, the muscular system is best trained by general gymnastic exercises, before applying its developed powers to any special purpose of peace or war.

The etymology of the word "Education" itself,—derived from Educere, Educare, to draw out—attests the length and permanence of this view, and though the present signification of "information," indicates knowledge, even the word "informare" at first implied as fundamental an operation of the mind as educare forming and giving a defined form to a mere potentiality of thought in the human mind.

But even in the primary period, when any direct and special commercial instruction is, of course, out of the question, considerations of utility have never been entirely foregone, and, while the educational problem has been to form mind and character on general lines applicable to the vast majority of mankind, its solution has, nevertheless, properly proceeded in a resort to some subjects which, while disciplinary, are also of general practical service, such as are, indeed, the three R's.

Good grounding and thoroughness in primary work, (the term of which, both for whole and half-timers, in our public elementary schools ought to be extended in pursuance of the resolutions at the Berlin Conference), is the absolutely necessary basis of all secondary and higher training, whether professional, technical or commercial; and this was not only enforced at the recent Conference on Commercial Education at the Guildhall, over which I had the honour to preside, but has been impressed upon me by the reports of the staff of several Technical Schools which I have recently visited, —at Nottingham, Huddersfield, Blackburn, Keighley, Oldham, and elsewhere, in which the far too common complaint is that defects in elementary training in general knowledge and science are the great obstacle to the conveyance, and a full realisation of the value, of scientific and technical instruction.

Foreign experience is the same, *e.g.*, Mr. Consul Powell, of Stettin, tells us that Germany has been able to cover the country with Commercial Schools chiefly within the last ten or twenty years, while we have been thinking and talking on the subject, just as she gave us the example of technical education, owing to the excellence of her general educational system, a system the primary part of which preceded ours by three-quarters of the century, and which must make memorable for ever the words of

the great minister, Stein, to his Prussian King, "Sire, we must make up intellectually what we have lost materially,"—words which sprang up from the field of Jena, like the mythical letters from the Dragon's teeth sown by Cadmus in Ancient Greece, and bore their fruit at Sedan, where the disciplined mind of Germany overbore the mind of their former conquerors. The Duke of Wellington said our battles were won in the playing fields of our public schools; —those of Germany were won in the schools themselves. So Moltke said the Prussian schoolmaster won the battle of Sadowa; it was a victory of the Prussian over the Austrian schoolmaster.

Equally, in the stage of secondary or intermediate education it is generally agreed,—and this agreement has just been almost unanimously re-enforced by our only Minister of Education, Sir John Gorst, and by both educationists and men of business at the Guildhall Conference,—that youths in this stage are to be regarded as still within the domain of the schoolmaster, and not of the man of business, and that specialisation in mercantile matters is premature, except, of course, to the extent of the conventional subjects I have mentioned; and except in the resolute insistence in "Modern Sides" of schools of more commercial arithmetic (including, of course, the metric system), and upon the inclusion of at least one foreign language taught conversationally, elementary drawing, and physical science (taught experimentally). The ordinary curriculum would naturally include English composition and geography and history, and the latter may well comprise the duties of citizenship.

Personally, as one who believes that the danger of over-pressure has been exaggerated, and has often been made an excuse for immobility in the beaten tracks, I would have attention given at this stage, in the case of youths known to be intended for business life, to commercial geography, a subject of great interest, and also to the elements of political economy, while others at the Guildhall Conference emphasised, I think rightly, the essential importance of good handwriting, and some the value of the early teaching of the principles of book-keeping. A few desired the addition of shorthand.

The principal subjects recommended at this stage may, by good teaching, all be made disciplinary; languages are best commenced young; experimental science appeals to curiosity and the imagination; and they will all become, in business, absolutely necessary, too often when it is too late. Let them, then, be first taught, at any rate, how to be learned, by the schoolmaster; not, as in my own case, after four years at a great public school, by myself, and let us also take care, that in future the schoolmasters, as men of business have to do, quickly conform at all stages of education to demands and changes which may properly be made upon them and their curricula owing to the exigences of modern business life.

Subject to these observations, however, in which I think most men of business would concur, there is a general agreement that, at any rate in the earlier part of the secondary stage, not much, if any, more than the above is requisite, coupled, however, as it must be, with good and thorough teaching, with a view to the formation of character and to the cultivation of a love of knowledge, for if a man is once made to love learning he will have learning.

And, of course, variations must be made to meet special cases; indeed, the last thing to be desired in education is such a stereotyped uniformity as that of the older Lycées in France; it may be said even of Mr. Squeers that his methods were various and his instruments elastic.

On some points of principle and practice, however, we have come to a distinct parting of the ways between the older and the newer schools of education, between the ideas of the older dominie and the modern merchant and schoolmaster. When the generality of our grammar schools were first founded the classical portions of their curricula were in accord with the spirit and comparative leisure of the age, and, even now, if a youth's time for education is unlimited, much may be said for Greek, and much more for Latin, as most perfect instruments of mental discipline and culture, while even metaphysics may at least be heard in their own defence through their professor at Edinburgh: —"This road," chalked a student on the door of his class-room, "leads to nowhere." "Nevertheless," chalked the professor underneath, "a good road to take exercise upon."

But nowadays life-time is brief, and school-time is fleeting, and that time has been too often worse than wasted in Greek and Latin verse-making and word-mongering, without a hope of penetrating even the outermost chambers of the literature and language the pupil is supposed to be studying. Better, then, if such are the vestibules, to accept them at once as

the warning of Plato over The Academy: "He who is ignorant of Geometry may remain outside." As the schoolboy himself sighed: "It is a good thing the Romans never had to learn the Latin Grammar, or they would not have had time to conquer the world!"

And, let me here recall the historical fact that, even in these early grammar school days, which coincided with both the making of education and the making of our colonies and commerce—the times of the Tudors—the merchants of London realised that some special training for trade was a necessary supplementary part of the educational system of a great maritime and mercantile power. For they founded such a school for commerce as Gresham College, of which we know that its halls were so crowded out with students that they thronged the very courts, lanes, and alleys of the City, and, so great was the fame of its utility, that King Francis, of France, sent a Royal Commission to study its systems and success, whose Report led to the formation of the equally famous College de France. Thus England, in the time of the making of her trade, was the home of commercial education; may it never be quoted, as a symptom of her unmaking, that in these latter days we continued to import it wholesale,—like too many of our commodities,—in clerks "made in Germany," or in other human cases indelibly marked with some foreign country of origin.?

Let us be warned by the story which has led up to such results. Our grammar schools became anything and everything but grammar schools, though it is quite true that many schools have been reformed by schemes of more or less merit, remitted by Parliament for discussion in the dead of night,—for they are taken only after midnight, when men who have business to attend to next day have mostly left the House. True, too, so-called "Modern Sides" of schools have been formed, but in many cases they are even yet shams, and in many are given no real chance, owing to the social atmosphere of our public schools. This I say on the authority of masters at some of the greatest of them. They are something very different from their nearest counterpart, the Realschule of Germany, whose teaching is practically the grounding for a business life.

Hence the growth of real reproaches—such as, that our pedagogues taught, instead of live languages,—

> "The Languages—especially the dead;
> The Sciences—especially the abstruse;
> The Arts—at least all such as would be said
> To be the most remote from common sense."

And satire, such as that put into the mouths of school men themselves, with methods so out of joint with the times: "We know nothing of science here—we don't even teach it." And students' sarcasms in their examination papers: "The Romans never produced a philosophy of any moment. Account for this." Answer: "I cannot unless it was that the Latin language was too clear for that sort of thing."

Remonstrance and reaction naturally followed, but, while, admittedly, improvement in our secondary teaching has even already resulted, that system and stage of public instruction itself is still in a somewhat chaotic condition, under no responsible Minister of Education, such as was authoritatively proposed by a Government so long ago as 1867; with no central or local authorities or areas; with no authorised tests of either teachers or their teaching, although we all know the truth of the Prussian maxim: "As is the master, such is the school," and "To make our education great we must make our educators great;" with no systematic grading or co-ordination, resulting in overlapping and waste of both educational and financial resources; and with little but voluntary, and often spasmodic and misapplied, and of any sort.

No, it is due to Parliament to record that it *has* granted some aid, in its usual fashion, leading partly to its most admirable use, partly to unwise economy of local rates, and to some extent to further waste.

A year or two ago, the Chancellor of the Exchequer proposed to tax their beer and spirits in order to reduce public-houses at the expense of the publicans; but the publicans, and even the teetotalers, were also sinners, and would have none of it; and so the "whiskey moneys" were thrown at the local authorities almost to drink or to do, or not to do, what they liked with them. Some did nothing; some something; most boroughs and some counties were wise enough to devote all to technical and also, in part, to secondary education, which, unlike the Science and Art Department, they were held to be at liberty to do; and some boroughs have even rated themselves for the same educational purposes.

Thus, just as some boroughs have recently had Peers for Mayors, whose arms and signs have thus been made to hang out not only from the public-houses, but also from the mansion houses of the country, so the unappropriated cash of the publicans was suddenly diverted from their casks into the coffers of

County and Borough councils, which, though absolutely inexperienced educationally, have justified the confidence of a Chancellor embarrassed by riches, and in this haphazard way Parliament has done something for technical and commercial education, while the schools have since been distilling learning out of liquor, and business out of beer.

And now, happily, whatever obstacles have existed to the production by the Government of a better Secondary Education Bill than those of 1896 and 1897, are, so far as concerns local areas, likely to be removed by a compromise effected between the county and non-County Boroughs, under which, while County-Boroughs and Counties will form, as of course, such local areas, non-County Boroughs may become so, if they satisfy the Central Authority that they have the necessary educational means and machinery—a compromise far better than the ministerial one, in 1896, of a population line drawn at 20,000 inhabitants; and, with the same object, some are prepared to vary the Bill of 1896, which was in this respect satisfactory to the Municipalities, by making the Local Authority to be a Committee appointed by the Town Council, with independent powers, and with members co-opted from School Boards and other educational bodies, and though, personally, I greatly prefer municipal autonomy, and reserve my own course of action, the principal consideration is, in the interest of Public Education, to secure, if not the best Bill, the best Bill we can get for the organisation and reform of secondary instruction, if, chiefly, with the object of promoting Commercial Education.

Meanwhile the popular demand for a greater adaptation of Education to the wants of the day has steadily grown, especially among the manufacturing and commercial classes.

And this feeling has been stimulated by the experience of the rapidly growing industrial competition of other nations, and an increasing knowledge of its contributory causes, one of which is firmly believed to have been greater knowledge based on better Education. *Fas est ab hoste doceri*, and the Reports of the Royal Committee on Technical Education, of the Iron and other Trade Delegations, of the Society of Chemical Industry, of our own Consuls, and of our Chambers of Commerce have opened men's eyes to our educational shortcomings and to the necessity of commercial self-preservation.

Happily, though late, but, let us hope, not too late, much has been accomplished for Technical Education, partially by the State and partially by Local Authorities, much by City Companies and largely by local patriotism in founding scholarships, prizes, and otherwise, though, as ever, in the wrong order, for secondary general education is the proper basis of Technical Instruction, and we have put in half the third storey by shoring up, instead of building, half the second, and, though necessarily, before the first storey, and even the foundations, have had time to settle. However, let us be thankful for tardy mercies, and hope that what we have built, though much in skeleton, has had at least some benefit from that wisdom which, by avoiding mistakes, comes best from the experience of others. For instance, we have wisely blended in our splendid Municipal Technical Schools, theory and practice; we have made the school not the substitute for, but the complement of, the workshop, and have thus recognised the characteristic practicality of the English Artisan as compared with the somewhat too professional teaching of many foreign schools.

At the same time, we have unfortunately yet very much to learn from our foreign friends and rivals. Compare our best Municipal educational work, as at Nottingham, under the direction of such an able administrator and educational expert as the Town Clerk, (Sir Samuel Johnson), with such leaps and bounds as those at Strasburg, where, since France's Jena, only a quarter of a century ago, a University has risen, each of the eight departments of which is better than our best local work.

The University of the greatest modern seat of trade and commerce should be many-sided; it should be in closest touch with the commercial and business and trade life of the City of London and of all classes, including the masses, and it must, as I proposed at the Senate, unite commerce with culture, and training with trade by its highest teaching, and by degrees and diplomas in Technology and commerce, as many foreign and some British, Universities have already done. And, with these objects, it should be an outward and visible sign of culture, instead of being, as it long was, a tenant in a common lodging-house in Piccadilly, or as at least it is now, sole tenant of far too small a building in a back street, or an exiled outcast stowed away in a genteel suburb, far from most of those who want to use it.

Meantime, while Technical Education has most properly progressed, little or nothing has been done for its necessary complement, Commercial Education, by which we mean some

special training for trade, an education which aims directly at fitting the individual for the requirements of commerce, and the greater adaptation of general instruction to industrial purposes. The Science and Art Department has been restricted from making grants, or giving prizes, for commercial subjects, as for science and art; comparatively very little has been applied, though there is power to do so, from the Funds appropriated by Parliament to Technical Education purposes, though I have seen at some Technical Schools some slight provision for Commercial Classes; what has been done has been chiefly accomplished by voluntary action on the part of the London Chamber of Commerce since 1887, by the London School of Economics, by the Technical Education Board of The London County Council, with its wise liberality in scholarships and prizes, though, as I have said, the Examinations of the Society of Arts, and, very recently, by the establishment of a School of Commerce at Liverpool, and these seem to be the only present sources of Higher or Tertiary Commercial Instruction or Examination in our own country, though it is due to acknowledge the different, but still valuable, services to Commercial Education of The Birkbeck Institution, certain Polytechnics, and also of Clark's and Pitman's Commercial Colleges, both of which, while having constituencies of a different class, are doing, to my own knowledge, very good work, Pitman's School having a Bureau similar in principle to that which I shall mention in connection with the Commercial School at Genoa.

And yet to have improved production through Technical Education, and to have neglected provision for better distribution, through Commercial Education, is again doing only half our duty, and tends to make what we have done largely futile and even wasteful. Our commodities are made to sell; they are, owing to competition, very difficult to sell; trade is becoming more and more international, and, as we have found by our Exhibitions at the London Chamber of Commerce, many of our wares are being displaced by foreign competitors even in our own colonies. Yet, how can we properly commend, and sell them, if we neglect to arm our people, and their Business Managers, and Heads of Departments, our Travellers, Agents, and Representatives with the chief instruments of international trade—foreign languages; if we fail to make acquaintance with the best machinery and methods of business in other countries, and to learn their terms of credit and systems of doing business; if we ignore their tastes and wants, and even their orders and directions; and if, instead of learning their weights, measures, and money systems, we still try to force them to swallow and digest the feet, hands, nails, palms, quarters, and even the hides, of our aboriginal ancestors?

As the mover in Parliament of the Select Committee which reported in favour of the adoption of the Metric System, I must, even again, urge the vital importance to our trade and traders of the universal teaching of this branch of arthmetic in, not only all Secondary, but also in Elementary Schools, a point which we attained, together with the complete legislation of metric weights and measures, by our deputation to Mr. Balfour, and through the Act of 1897.

At present, our ignorance of it isolates us commercially, and is a great impediment in our own international dealings.

Nevertheless, our own Consuls have told us, almost with one voice, that what I have spoken of are the banes of British business; they urge the dearth of educated British commercial travellers and agents, as compared with the representatives of other competing nations; and one of our Colonial Premiers himself told me of our want of trade knowledge and adaptation, in that we lost the supply of hosiery to his colony—a free trade one—and compelled it to manufacture for itself, simply because we either did not know, or would not believe that the average colonial thigh was proportionately longer than ours, but would insist on the colonists wearing our own common measures of "pants," whether they fitted their legs or not. The Consuls also tell us—what is simply commercial knowledge, *i.e.*, the product of commercial education — that other people will and do speak, write, commend, catalogue, quote, invoice, and the like, in tongues understanded of other peoples, and that some of their travellers would almost have made their fortunes as universal interpreters at the Tower of Babel; and that if the natives prefer tea-pots with two spouts, or two handles, or goods of a different quality or design, they make them, while ours too often say they never heard of such things and won't trouble about them, when, of course, customers won't trouble to deal with them; and all this while the London Chamber of Commerce exhibitions, to which I have referred, have convinced those who saw and studied them, that if we could only learn to adapt ourselves more to the

requirements of other nations, which it is one great object of technical and commercial education to make us able to do, we could, in most cases, supply their wants better and cheaper than our more successful competitors.

I wish particularly to emphasise the case of commercial travellers, agents, and other representatives abroad, and the necessity of their greater acquaintance with the modern conditions of successful trading, and especially with foreign languages. The want of such skilled and qualified representatives of British traders is the bitter cry of our Consuls.

For instance, in Italy, the few travellers employed by us as compared with the German legion, with its samples, price lists, quotations, &c., in Italian, is one of the chief causes which militate against us. Again, in Denmark, the number of foreign commercial travellers may be ascertained from the licensing authority, and I find that while, in 1896, 84 visited that country from Great Britain, no less than 764 came from Germany, exclusive of 171 from Hamburg alone!

Even in the case of Africa, we are said to have been outnumbered by 20 to one. It is more satisfactory to read from Mr. Worthington's recent report on Argentine and Chili, that complaints on the score of languages are now not so much heard—some testimony to our past urgent encouragement of the study of Spanish and Italian—though the want of familiarising with general business conditions is still our great disadvantage.

My own experience has confirmed these Consular complaints, sometimes humorously. I have heard a Yorkshire merchant ask in a foreign shop for a kilometre of polony—upwards of half a mile of it; and an experience of an Alderman, manufacturer and merchant, who spoke nothing but English, was thus told me by himself: "I went to Paris, staying at the Hotel de Lille et d'Albion. Never having been before, I lost my way, and could not find my hotel again, because I neither spoke nor understood French. Thinking some of the people I met might understand written English, I went into a stationer's shop and bought a large card, on which I wrote 'Please tell me the way to the Hotel de Lille et d'Albion.' Again I sallied out, showing my card to several, but still to no purpose. At last a gentleman read it and silently beckoned me to follow him, which I did as silently, for a mile or more. Then he pointed, still silently, to the sign of the hotel, and when I saw it, I broke the silence by exclaiming 'Thank you.' 'What,' he replied in amazement, 'are you an Englishman? So am I, but I took you to be deaf and dumb.'"

Now, we are lamenting some loss of British exports. I think little of the relative increase of the volume of trade of most other countries; much of it owing to our long monopoly of coal machinery and shipping, has sprung from comparatively very small beginnings, and, with the greater equalisation of instruments, there must be a large relative per-centage increase; but the comparative decrease of our exports demands some attention, in face of the fact that during the present decade those of Germany and Central Europe have increased 13 per cent.; those of France $1\frac{1}{2}$ per cent.; and those of the United States 18 per cent.; while British exports have decreased 5 per cent.

No doubt there is a plurality of causes for this, over some of which, such as that of the Suez Canal in restoring the old trade routes to, and centres of distribution in Central Europe, we have not only no control, but compensation in benefit to our carrying trade. Neither do I stop to inquire whether freights in that trade—invisible imports—or interest on investments, paid through imports, our living upon capital, &c., furnish adequate explanations of the balance of our trade in the excess of imports over exports. The fact remains that our exports are decreasing.

In a moment I shall ask what we know, but I first reinforce the argument by adding a reassuring instance of a lost trade retrieved entirely through technical and commercial education, as I might also add many instances of the saving of towns from the effects of dependence on one staple industry, which has become depressed by means of technical knowledge, which thus promotes the easier flow of capital from one industry to another by helping to overcome what I have elsewhere termed economic friction. This is one of the strongest arguments in support of technical and commercial education.

Luton was a chief seat of the straw-plait trade, which it very largely lost owing to foreign competition, so the Municipality and Chamber of Commerce jointly procured the best teachers and had taught the newest methods of manufacture and of business. Much local opposition had to be overcome; but gradually the expenditure and work produced its effect, and soon both the home and

xport trades of the town were restored, he people being well armed for competition, ınd the wages of the working-classes were ncreased by 100 per cent.—a good objectesson in technical and commercial education.

Now, what do we know? That, languages ›eing, as I have said, the chief instruments of nternational trade, have been sedulously cultiated abroad; that, for instance, at Hamburg, English has, for more than a quarter of a entury, been a compulsory subject in its public lementary schools, and that one of our own Technical Commissioners tells us that he saw ›ver a class-room door in a school in the nterior of Germany: "Nothing but English o be spoken in this room to-day."

Again, the London Chamber of Commerce nade, in 1888, a systematic canvass of our City ›ffices, and found that no less than 35 per cent. ›f them employed foreign clerks for their nowledge of foreign languages, and ability to orrespond in these commercially, though the ›rincipals generally preferred Englishmen, and hree hundred leading firms have since signed ın undertaking to give them the preference, ›ther things being equal. One of these clerks s said to have written to his friends at home, aying: "There are still some English in our ›ffice, but less than formerly."

This is now some few years ago, and let us ıope that the tide of foreign invasion has been temmed. It seems so, for the Chamber has ıever failed to get a good situation, at a salary ıigher than the average for students holding ts Commercial Education certificate, if in ›ther respects eligible.

The Chamber next inquired into the state of econdary and commercial education, and ound much cause for the condition of affairs n the curricula of our schools not being ufficiently adapted to commercial training. This is the result of an independent examinaion conducted on behalf of a great mercantile London house, whose name I must not disclose, ıs an entrance examination for apprentices. The examiner wrote to the firm as follows:— 'The experience I had last winter in the lasses for your apprentices induced me, in etting the examination papers, to adopt a ow standard with the object of finding out what he candidates *did know*, rather than what they *did not know*. The average marks were in nental arithmetic:—41·6 per cent., 7 candidates eceiving less than 10 per cent.; in tots, 71 per ent.; in commercial arithmetic, 25 per cent, 1 candidates obtaining less than 10 per cent.; in English composition and grammar, 29·6 per cent., four candidates obtaining less than 10 per cent.; in dictation and writing, 65 per cent., one candidate obtaining less than 10 per cent.; and in French, in which there were sixteen candidates, 32 per cent., five obtaining less than 10 per cent. The candidates were exceedingly weak in commercial arithmetic, letter writing, and in correcting ungrammatical sentences. They showed the best results in rapid addition of money columns, four obtaining full marks. I was amazed to find that most of them had not the slightest knowledge of geography. Pointing to the map of the world, I was informed by one that China was France; only one of the whole number knew Japan; South America could not be distinguished from Africa; only two could name any place in the world where sugar was produced, and the same thing applied to raw materials (cotton, silk, wool, &c.) and manufactured articles. I saw nothing to indicate that these boys were below the average of intelligence. Their condition of ignorance seems to me to reflect very seriously upon the teaching they have received. I naturally inquired what schools they had attended. Practically all had been to secondary schools, second grade grammar schools, private commercial schools, &c. If these candidates are representative of secondary education, I can only give it as my opinion that a revolution is required in the teaching staff and the methods of teaching, to put it on a satisfactory basis. Evidences of unsystematic teaching and slip-shod methods occurred on every hand."

Again the head of one of our largest insurance offices, which also examines all applicants for its clerkships, has sent me a typical examination paper done by a boy from one of the greatest London public schools, of national reputation, of a boy who brought the head-master's leaving certificate that he had "been at the school for several years, and had made creditable progress in his studies." Yet this youth of nineteen managed to make two mistakes in spelling in four lines, and appeared to be like Mr. Weller, who said how to spell depended on the taste of the speller—*e.g.*, he spelt accommodate "accomordate," and Piccadilly "Piccadilee;" he was no good at compound addition or per-centages; he could not name the counties of two large county towns out of four; he wrote that Queen Victoria was of the House of Tuder (*sic*); and when asked where the National Gallery was,

he said in Leicester-square—a confusion of mind which indicated familiarity with amusement rather than art. The gentleman who sent me the examination paper—himself an experienced educationalist and an active member of the council of one of our university colleges and public schools, wrote me thus:—

"It has been my duty during some twenty years to examine young men candidates for commercial clerkships, and my observation has shown some serious defects in the practice of the so-called 'public schools.' The hand-writing, spelling, and knowledge of geography, have frequently shown sad deficiency. The badness of the first of these is probably to be attributed to the custom of exacting the writing of a thousand or more lines in play-hours as a punishment. This appears to be a cause of the loss of that elegant and legible handwriting so characteristic in former years, but that a pupil who carries off prizes for mathematics should fail in adding correctly simple columns of figures, or in a common Rule of Three calculation, or in correct spelling of English words, is to me very striking. The very rudiments of commercial education are thus neglected, as you will see exhibited in the examination paper (which I send you). This is not an exceptional case; I might furnish many such."

These are the experiences of large business houses, and the testimony of independent examiners, which is confirmed by a letter I received from one of the higher masters at one of the greatest of our great public schools, who wrote that he agreed almost *in toto* with every word I am now expressing.

Then, the Chamber, through its Commercial Education Committee, which has had the very great assistance of such able and experienced advisers as our Chairman, the head-masters of King's College School, the City of London School and others, set to work to try to change the aspect of affairs by rousing public attention upon the subject, and by giving to our equally capable and willing clerks and others more modern intellectual and mercantile equipments. And with what results? Latin, for literary reasons and for the sake of style and expression, many, including Sir John Lubbock, tried hard to retain as a compulsory subject, but we were told by the education experts themselves that if so we should not have ten candidates at our examinations! So we made it optional. Exactly the same advice was given us as to requiring, as we first proposed, two foreign languages. So, disappointed but practical, we contented ourselves for the time with one; and, after other similar deductions from a moderate standard of junior commercial education, we were again assured by many that it was too high, but the mountain would no longer go down to Mahomet and so Mahomet has had to come—and has come—up to the mountain.

Moreover, we have done our best to teach through lectures and classes, with the aid of such men as the Rev. Dr. Cunningham, of Cambridge, Professor Hewins, of the London School of Economics—of the co-operation of which the Chamber has had the advantage in joint work, and which has itself done such excellent work for higher education in London—Mr. Montague Barlow, and others.

It is also to be remembered that, at the Chamber, we have been no worshippers of what some people regard as the Divine right of examining other people.

On the contrary, we have regarded examinations as only rough and ready, though necessary, means to an end—as some test of learning and teaching; and, by our Table of Equivalents, prepared with great care and trouble we have gladly dispensed with our own examinations, either wholly or in part, where equivalent knowledge has been certified by a competent educational authority. We have relied for the attainment of our objects more upon our senior ane junior suggestive courses of commercial education (rather than on examinations), as indications of what youths ought to be taught and to know, and it is most satisfactory to be assured that the curricula of many secondary and other schools has been thus improved from the commercial point of view while we know that hundreds have been taught in school upon our prescribed lines of study, of whom only a very small per-centage have entered themselves for examination.

The Lord Mayors and City Authorities have encouraged our work by giving prizes, and otherwise; the City livery and other Companies and firms and individuals have enabled us to offer travelling and other scholarships, prizes and rewards—the first for the better acquisition of foreign languages colloquially in the foreign countries themselves—and the results, numerically, have been very satisfactory, upwards of 1,200 candidates having presented themselves—those in 1898 being by far the largest number—of whom, the proportion having progressively increased, 681 have obtained the Chamber's certificate for more general commercial education at the junior, or for one or more special branches of commercial knowledge at the senior, examinations.

The reports of the examiners, indicating, as they have done, a progressively improving

state of knowledge, have been satisfactory and reassuring, and continuity, and the practical and up-to-date character, and the standard of examinations, have been maintained by the appointment of mercantile members of the Chamber as moderators.

These commercial examinations have also been conducted by the Chamber in provincial centres, the list of which is still increasing, and in India. One incident of the last examination at Bombay is worth noticing. We hear much of Indian competition with Lancashire in the cotton trade, especially in the lower counts of yarn. Now, book-keeping is the basis of successful business, and the examiners in Book-keeping write thus of Indian candidates:—

"Special mention should be made of the fact, that whilst 13 out of 14 Bombay candidates passed, three with distinction, the average per-centage of marks gained by them was slightly over 11 per cent. higher than that obtained by those sitting at the London centre, one candidate (No. 162) being entitled to special mention, he having been awarded more marks than any other candidate sitting in London."

The Chamber is just raising, as it has done previously, among its own members and by an appeal to City companies and others, a fund to continue this work for some years yet, but its financial resources are limited, and ultimately the task must be undertaken either by the University of London or by the London School of Economics, and the City of London College and similar institutions in London and the provinces.

Already one significant, if experimental, new departure has been made. The Chairman of the School Board, the Rt. Hon. Lord Reay, himself an educationist of the highest standing, was a silent but apparently an appreciative member of the Guildhall Conference. Immediately afterwards, the School Board founded three evening commercial schools, at the opening of the first of which, in North London, I was present, and was greatly impressed by the large number of teachers and scholars assembled, and by the educational enthusiasm displayed. The curriculum is good, though of course more limited than that of a day school. Moreover, such a school may, of course, be said to want the broader basis of secondary instruction, but Higher Grade Board Schools really give this in many cases to School Board pupils, and so, though less completely, do the evening continuation schools; and there are qualifying examinations at the commercial schools themselves. And, at any rate, the step forms an experimental advance in a right direction. Moreover, as in primary education, it behoves the secondary schoolmaster to be abroad, and the employer to be awake, or the craft of each may be endangered, while both may be outstripped by the output of our public elementary schools, for which they have themselves largely paid; and, if so, and if the State is thereby served, no question of class or vested interests will make it possible to retrieve such mistakes or to retrace such steps.

Of course, one conscientious objector immediately presented himself; in this case in the person of the Chancellor of the Exchequer of the School Board. This was, equally, of course, the one thing which made him anxious, in the preparation of his School Board Budget. He shuddered at the cost, as if the expenditure were not reproductive. An American statesman once said "Our School-rate is our highest one, yet we pay it the most cheerfully." Properly administered, it is a source of saving to the State, in reducing other and more obnoxious taxes, and in making useful and creditable citizens. Some few may fail, and some few old women may immediately cry out, as one did at a case of forgery, "This is what comes of your reading and your writing." But, regarding men and women in classes, the more educated they are the less they yield, as a whole, to temptation and lapse into vice and crime, and so become a burden instead of a benefit to the community. Or, putting it on a lower ground, let us remember what our Technical Commissioners were told at Chemnitz:—"Our Technical and Commercial School has been worth ten times its cost, and you have paid for it in the higher quality and prices of our goods;" or, learning from our own industrial history, may we not remember that if, by enlarging the area of potential inventors, we should discover but one industrial genius like Watt, or Crompton, or Arkwright, or Stephenson, we should be repaid the cost of years, both capital and annual expenditure, a thousand fold.

It is to be remembered, too, that the policy of the Rev. Stuart Headlam, M.A., Chairman of the Evening Continuation Schools Committee of the Board, and his Committee, means, by prolonging education, the saving of much of the millions now spent on elementary instruction, at a cost of only some £40,000 a year, even when such continued education is free, as it now is; it also helps to redress the evil of the early age at which children

may leave our public elementary schools; it utilises school buildings and other educational machinery which would otherwise be idle; and it contributes to some increase of the emoluments of teachers, and thus helps to raise their influence and status, and to render their great profession more attractive.

Lastly, judging from experience at these foreign schools, and from the opinions (which are afterwards summarised by the Chamber Conference Committee) of experts and business men at the Guildhall Conference, what seem to be the most practical lines of procedure in order to effect our immediate purpose? First, to strengthen somewhat the staff of teachers in secondary schools, in order to secure more efficient teaching in their "Modern Sides." For this and other purposes, financial assistance should be given by both the State and Local Authorities, through grants in the nature of those of the Science and Art Department; but paid, preferably, for efficiency of the Modern Sides of schools, rather than by way of grants *per capita* for single subjects, which is not regarded as a satisfactory system. Municipal Corporations, County Councils, Urban Boards, and Chambers of Commerce, with or without the aid of the State, should co-operate in the establishment of Higher, or, as Mr. Macan has styled them, Tertiary Schools of Commerce, in the large commercial centres, and these should be affiliated, if possible, to University Colleges. The subjects should not only be special, but should be strictly adapted to the future career of the student. No rigid curriculum should prevail in any one institution, much less in the institutions generally, but there shonld be various definite courses of study, comprising the following subjects;—

1. *Economics and Allied Subjects*:—(*a*) History of Economics and Trade; (*b*) Political and Commercial Geography, including Trade Routes; (*c*) Study of Statistics.

2. *Modern Foreign Languages.*

3. *Business Methods*: — (*a*) Commercial Arithmetie; (*b*) Book-keeping and Accountancy; (*c*) Commercial Bureau; (*d*) The Machinery of Business, Banking, Insurance, the Stock Exchange, Lloyds, &c.; (*e*) Study of Commodities; (*f*) Transport and Means of Communication.

4. *Law.*—(*a*) Commercial Law; (*b*) Industrial Law: Factory and other Legislation; (*c*) Principles of International Law; (*d*) Fiscal Legislation — English and Foreign — Commercial Treaties.

5. *Commercial Subjects touching Local Industries.*

It is to be hoped that the Senior Examination of the London Chamber of Commerce, and of other Chambers, may be brought into close association with the work of institutions of this character, and that, on the results of these examinations, suitable scholarships and exhibitions may be awarded by City Companies and other bodies to enable the poorer scholars to avail themselves of the advantages provided.

As to employées in business, the attitude of the Guildhall Conference was not so definite, as it was felt that the members of this class, whose school education ended at the age of 12 or 14, might not, as a rule, or as yet, be educationally prepared to enter upon systematic courses of study. The discussion at the Conference also made it clear that, under this head, a large amount of important work is already being done in our admirable and most successful Polytechnics, Evening Continuation Schools and Classes, and Evening Technical Schools, in most county, and some non-county, boroughs and counties.

These should be encouraged in every way: continuation schools principally by the primary authorities, *i.e.*, school boards and voluntary school managers, and the polytechnics and technical schools by State and municipal authorities, and charity and other trustees. It must not be forgotten that, in the evening classes, the work done will be more limited in the range of subjects, and less complete in treatment, than in the day institutes. A system of Government grants for continuation commercial courses is very desirable.

In the Evening Continuation Schools the subjects to be encouraged, during a course of about two or three years, are chiefly:—Arithmetic, handwriting, book-keeping, shorthand, type-writing. The teaching of drawing, history, geography, and elementary science may well be given, especially to those who may not already have acquired in the day schools the elements of these subjects.

Exhibitions from the continuation schools are needed to enable deserving students who have shown capacity to proceed for further study into the classes of a polytechnic. In this (the polytechnic) stage, the subjects studied should be, to some extent, those of a tertiary day institute, and the premises, and possibly some of the teachers, may well be the same for both purposes. At this stage, again, a student of marked ability ought to have an opportunity of obtaining a maintenance

cholarship, which would enable him to leave is day employment for a few years in order to tudy at the tertiary day institute. This inking together of the two systems (day and vening), which is practically one of the bases f the scheme for the new Teaching University f London, has been followed, with marked uccess in several branches of their work, by he colleges of Victoria University, and justifies he expediency of appropriating public funds or the expenses of higher educational work.

Perhaps, public attention being at length ivetted upon the subject, it is less necessary han it was to appeal for active aid in carrying n the task of commercial education for the eople. Even politicians and statesmen have t last spoken in its favour, and they seldom ry until the quarry is in sight; they enerally set out on the flowing tide. But, est there be any doubt, let me, objectionable s it is to have to do so, once more stimulate ny countrymen by the example of competing ations, as needed to be done, and was ortunately successful in the case of primary nd technical education.

In Paris, Bordeaux, Genoa, Munich, Nuremerg, Cologne, Frankfort-on-the-Maine, and ther places in which I have personally visited chools, there are higher commercial institutes, olleges, and schools, and classes, which have carcely any counterparts in this country. The same remark applies to business and commercial colleges of the United States.

The Paris Chamber of Commerce—and here et me say that Continental experience has hown that Chambers of Commerce, either lone or in conjunction with other bodies, are the est fitted for this work and for the administraion of the necessary funds—has established wo such schools, L'Ecole des Etudes Commerciales, in the Boulevard Malesherbes, and L'Ecole Supérieure de Commerce, in the Boulevard de la République; together with a hird, L'Ecole Préparatoire. The first of these, which I visited some few months since, gives he highest instruction in commercial subjects, nd has some 350 students from 17-25 years f age. It has a Musée des Marchandises ttached to it for their use, and excellent hysical and chemical laboratories and apparatus.

At the Superior School of Commerce, I was, few days ago, most courteously received by he director, M. Cantagrel, who told me I had ollowed closely upon the heels of my friend nd townsman, Sir Bernhard Samuelson. This chool, founded in 1820, and acquired by the Chamber of Commerce in 1869, has just been re-built, and is, architecturally, a fine edifice, thoroughly adapted to its purpose. It also is well equipped with physical and chemical laboratories, and has 200 residential students, of ages similar to those stated above, many of them university graduates. The hours of work are from 5.30, when the students rise, until 9 p.m. The commercial education given is of the very highest; indeed, these two Paris colleges really form a Commercial University, so far as that name can be considered a correct one. Perhaps, if any fault is to be found, it is that there are some indications of the characteristic defect of French education in the past—too much uniformity and routine, and too much of the professional, as against the practical, tone. Some of the domestic arrangements are almost ludicrous in their identity.

At Bordeaux I found a good High School of Commerce, and great interest in the work of commercial education; while at Genoa, again, located in an ancient palace, the Royal High School of Instruction in Commercial Studies, established in 1884, gives the highest instruction in commercial technology, economical and industrial science, and literary and philological culture, the results of which are attested by our Consul as excellent; moreover, successful graduates—the college confers a commercial degree—find immediate employment at high salaries.

A feature of the school is its "banco modello," or model office. Students in this department represent different firms in various parts of the world, and go through all the most minute operations of trading with each other, including transit of goods by sea and by land. Connected with these commercial houses are: a deposit and discount bank, a bank of issue, and a clearing-house, all being furnished with a complete supply of ledgers, forms, &c., such as are actually used in each department of trade. A good commercial library, machinery-room, museum of commercial samples, and a laboratory are attached to the school.

There is, I understand, a similar school at Venice, the trade of which, as of Genoa, is increasing rapidly; but this I have not yet had the opportunity of visiting. These great commercial cities of the middle ages, revivified by the restoration of the old trade route from the East to Central Europe and the Hanse Towns, which Vasco de Gama—whose quincentenary we have celebrated this year—robbed them of for the benefit of Britain, are again rising, and seem fully alive to the modern con-

ditions of commercial success. It is interesting to note that the oldest commercial school on the Continent—the Aula Commercio—existed at Lisbon, the City of Vasco da Gama having been founded in 1759 by Pombal. So also, as the result of this change, are Hamburg and Antwerp greatly expanding,—the former the seat of the first commercial school in Germany and the latter of the best in Belgium. These cities are quickly becoming the great distributing centres for North and Central Europe, and are making their rivers and harbours attractive to commerce, at the expense of London, and one of them, Antwerp, we know from its own people, attributes much of its recent rise to commercial education at its Higher Institute of Commerce, of which many English youths have been compelled to avail themselves. Commercial education is also provided at the Universities of Liège and Ghent, which confer degrees in Commerce.

The Antwerp Institute itself is, except in name, a commercial university, giving the highest education, at a very moderate cost, encouraged by travelling and other scholarships; and its practical results are shown by the following figures, indicating the commercial careers of its former students: 249 are principals or managers of large mercantile houses in Belgium, 218 are bank managers or commission merchants, 6 are consuls-general, 32, consuls or vice-consuls, and one is Home Secretary to the Congo Free State, while others are professors at foreign institutes similar to that at Antwerp.

Two important things are to be said in reference to the commercial education of Germany: First, to repeat, that her primary and general education,—longer and still better in many ways than ours,—has given her a foundation on which she has been able to build a wide and deep superstructure within the last ten or twenty years, assisted by the previous possession of the oldest and best precedents and types of commercial schools—as at Hamburg from 1768; Leipzic from 1831; Gotha from 1817 (refounded in 1888); Lubeck from 1829; Dresden from 1854; Chemnitz from 1848; Munich from 1868; and at Nuremberg, Augsburg, Zwickau, Altenburg, and elsewhere.

And, secondly, that this building-up has been chiefly in her manufacturing districts—where, in some cases, attendance at commercial schools has now been made compulsory—enforcing by experience any argument that aid to productive and distributive industries should be complementary, in the shape of both technical and commercial education.

But whether the increase of commercial schools in Germany is a cause or effect of improved trade and ability to compete, which matters little, since it is at least coincident with that improvement from the early seventies in that country and its State, municipal, and commercial organisations of all kinds is alertly alive to the benefit which such schools have done, and can and must do for commerce and for competition; and commercial education has become widely distributed and is being quickly organised. Living languages are more than ever the study of commercial students and clerks, with English and English Correspondence—like French, taught conversationally—ever at the head of the list, and Italian, Spanish, and, already, Russian for colonists to German China. The mailed fist is being gloved.

There are now in the Empire one commercial university (Leipzic) and large numbers of commercial schools:—(1) Primary commercial schools for instruction in, and the continuation and extension of, mercantile knowledge; (2) schools for apprentices, giving exclusively commercial instruction in the early mornings and evenings; and (3) higher colleges and institutes or schools of commerce. Commercial education is also given in the higher public schools, as at Frankfort-on-Maine and other places, and Munich, where there is also a commercial school for girls, which I visited and found to be excellent, as is also its industrial university.

In somewhat more detail, the School for Commerce of Leipzic, managed by the Chamber of Commerce, gives the very highest mercantile education, and has its own mercantile museum, library, and laboratories, for research, &c. Since the foundation of this school it has been attended by 17,000 students, including 3,000 foreigners. In Leipzic, too, a new departure has recently been made in the foundation of a Commercial College University, which successfully aims at the provision of education and studies of university rank, which has for its object a broader field than both the highest and ordinary commercial school, and which seeks to eliminate, as far as possible, merely utilitarian considerations. Upon this subject the very able paper by Mr. Laurie Magnus, read, together with notes, by our Chairman at the Guildhall Conference, should be perused by all who desire to become

quainted with the latest and best developments of commercial education.

Chemnitz, a great manufacturing centre, s its technical and commercial school, with commercial curriculum of a high class, a rary, a museum of mercantile productions, d laboratories. Arrangements also exist der which the students visit the local lustrial works. This, it may be mentioned, is o done in the case of primary school scholars Exeter, and is found to be a useful link beeen primary and technical education, as well a good educational instrument in itself.

ie Practical Commercial Institute at Lubeck, port of only some 60,000 inhabitants, gives highest commercial instruction, with the eciality that there is no teaching in classes. dividualism is its principle, there being no hool system and no fixed period of entry or it, the students being separately taught tual office work and the conduct of business airs, with sale, purchase, consignment, ipping, insurance, banking, and other partments. This, I may add, is also being ne at Pitman's Metropolitan School in ndon.

There is also another High School of Comerce at Lubeck educating in many languages d in commercial subjects.

Munich provides, through its municipality, its Royal Commercial School, the means of arning what is required in practical business e, and has, in addition, its Royal School of dustry, and its Technical High School.

At Gotha, the Commercial School lays stress the study of modern languages; the Comercial School at Stuttgart offers solid eparation for a mercantile career; as do ankfort-on-Maine, through the Chamber of mmerce, in the shape of university extension ctures on high mercantile subjects by eminent iversity and business men; and Cologne, ich has a Commercial School and a Higher hool of Commerce.

The above are types. In Prussia alone—r the numbers in Germany are not known; it they are very numerous)—there are now 6 primary commercial schools, with nearly ,000 students, many of them females. The mmercial expansion of Germany has thus en in part preceded, and in much greater rt accompanied, by commercial education, r Consul at Stettin observing that the lightened German man of business is fully nvinced of the necessity of a thorough and ecial commercial education, besides the usual neral education given to all, and that this feeling is advancing rapidly and fast permeating all commercial circles.

Much, indeed, the Consul adds, has recently been effected, City Corporations, Chambers of Commerce, Town Magistrates, and Mercantile Guilds, have, in both large and small communities, become alive to the fact that they not only serve their own, but also the interests of their country, by laying a greater importance upon secondary commercial teaching for their youths.

It is no secret that the whole of the Governments of the Federal States of Germany have recently given the most serious attention to the discussion of commercial education, in which discussion Prussia was, by no means, the least progressive. It is now stated that the Prussian Government is going to introduce, next Session, a Bill into the Landtag, to provide a considerable sum of money for the support of commercial education, not only with reference to the education of clerks, but also as a new department in University Extension, it being intended to attach to a number of Universities a special branch for the teaching of commercial knowledge in its more advanced and scientific regions, similar to the technical high schools at Karlsruhe and Darmstadt, which were the first to adopt the Leipsic method.

At Aix-la-Chapelle, Berlin, Hanover, and other places possessing technical high schools, special departments for commercial instruction are to be added, the efficiency and success of which can hardly be doubted. In short, the great interest in commercial education which has now been aroused in the various governments of Germany is sure to produce very considerable results before long.

A great and powerful union or society for the promotion of mercantile education (Deutscher Verband für das Kaufmännische Unterrichtswesen) has been formed, embracing all parts and States of the German Empire, which is working energetically and ardently for the establishment of new commercial schools. Courses are being given by this society for the instruction of teachers in commercial subjects in order to render them more efficient in the schools.

This union or society comprises in its membership 14 governments, 77 chambers of commerce and industry, 49 municipalities, 108 commercial societies, 101 commercial schools, 119 large firms in Germany together with wealthy individuals. This union or society has obtained the recognition and sympathy of 14

various governments to the extent of receiving pecuniary grants.

At the invitation of the Prussian Minister of Trade a large number of burgomasters, representatives of commerce and industry, headmasters of commercial schools met together on January 31 and February 1, 1898, in Berlin to deliberate on the different questions touching the development and extension of commercial education, the present state of the Kaufmännische Fortbildungs-schulen," the "Handelsschulen," and of the "Höhere Handelsschulen" was submitted to an exhaustive discussion, and the question as to whether or not it was advisable and necessary in Prussia to create besides the present commercial institutions already existing, new and independent "Handels Hoch-schulen," or to place them in conjunction with the Universities, resulted in the latter being decided on as the best means of forwarding the desired result."

These are incentives stated in the admirable report of our Consul at Stettin, in which the whole subject of commercial education in Germany is dealt with, even if one cannot concur in some of the conclusions of the writer.

We follow, we *must* now follow; but we follow with the advantage of the experience of other nations, and with, we may hope, the early assistance of a Commercial Intelligence Department, recommended by the Board of Trade Departmental Committee which sat recently under the chairmanship of Sir Courtney Boyle. This should greatly assist the commercial community, including commercial students, with information, and also by furnishing a library, and commercial museum, and exhibitions, and so aid the work of commercial education, in the foundation and spread of which the intelligence it is intended to collect and circulate must be of the greatest service.

We hnow already, however, that something must be done at once if we are going to arm our people with the weapons of intellectual precision which so many of our competitors hold and use against us. Let us then equip our equally capable citizens for the friendly fight, which still means for us national life or death, and enable each to realize the truth spoken nearly three centuries ago by a great townsman of mine, and the representative of that town in Parliament, an incorruptible patriot in an unpatriotic and corruptible age, one to whom our Metropolitan Council has very recently and rightly decreed a Memorial Tablet—Andrew Marvell:—

"How much one man can do
If he both act—and know?"

DISCUSSION.

The CHAIRMAN, in proposing a vote of thanks Sir Albert Rollit for his exceedingly interesting a able paper, said he was sure that all would agr that there was no man more competent than S Albert to place before a meeting the importan of the question of commercial education. I had approached the question not only from t educational side but also from the administrative sid he had sought the opportunity of visiting some the principal commercial schools on the continen and had brought to bear upon his knowledge those schools the experience which he had gained Chairman of the Educational Committee of t Chamber of Commerce. But there were two three observations which he (the Chairman) might permitted to make. One arose out of the difficul which everybody must feel in discussing the questi of commercial education owing to its close co nection with general education. In dealing wi technical education, one felt that it rested on a su foundation, say, of science and of drawing, but the matter of commercial education one miss any distinctive basis on which it was founde The defects which were at present found commercial clerks, travellers, and others we due to a great extent to defects in gene education; and if there was one fact which h been brought about by the discussion of th subject during the last ten or twelve years, it w that in commercial education it was certainly u desirable that specialisation should take place at to early an age. The recognition of this fact was mo important, and had been emphasised by the remar of the reader of the paper. Lord Reay, in di tributing the prizes at the Mansion House the oth day, very clearly pointed out that the classes persons for whom commercial education was need were commercial clerks, commercial travellers, t heads of mercantile houses and banks, and those the consular service. As regarded commercial clerk the education which they required ought to l obtained in public elementary and high grad schools, supplemented by evening continuation schoo managed by the School Board. He need scarce point out that in evening continuation schools the was a very great and important work in which t School Board might be occupied, and so long as t School Board did not venture to overlap the wo that was done by other institutions and bodies, was most desirable that they should endeavour t continue the education which was given in t public elementary schools in order to bridge over t interval that must elapse between the time when child left the elementary school and was capable proceeding to a technical school, properly so-calle As regarded commercial travellers, he thought th what they really wanted was a sound and thoroug secondary education. In order that this seconda education might be available for all classes of th

mmunity, and that secondary schools might be tablished where they were required, and that there ight be no overlapping of effort or energy, it was ost important that the Bill for the Organisation of condary Education, of which they had heard so uch, should come into operation. In connection ith this, he was sure the meeting would be ad to hear that a compromise had been estab- hed between county and non-county boroughs, hich he hoped in future would lie down together e the lion and the lamb. The difficulty of re- nciling their conflicting interests had been one of e causes which prevented the Bill for Secondary ducation passing through Parliament. When they me to consider the difficulties to which Sir Albert d referred, and which had been spoken to by nglish Consuls over and over again, namely, that erchants and commercial travellers were unable to dapt their goods to the wants of customers, they ust again feel that this probability was owing some defect in education, and that no amount of ecial commercial teaching would enable them to medy the defect complained of. It was surely due some want of sufficient exercise of the faculties of bservation and imagination which prevented their eing those particular wants which it was their duty supply. As regarded the higher class of edu- ation, or that which should be given to the heads of ercantile houses and large banking establishments, ey came to a question which required very careful onsideration. He had almost hoped that Sir Albert ollit would have suggested more fully than he had one the means by which this want might be sup- lied. He thought they all recognised that in that rade of education, called tertiary, there was room for pecial study and special instruction. At the present oment there were very few, if any, institutions in he country in which this kind of education was iven. In connection with this phase of the subject ne could not shut one's eyes to the activity which as being displayed by different continental countries, hey might be quite certain that Germany, France, elgium, and Italy would not be spending money as hey were now doing in establishing and maintain- ng large and important high schools of commerce nless they were convinced of the fact that the young nen educated in those schools would be able to mprove and advance the commercial interests of their ountry. That being so, they could not afford to be ehind continental nations, and it behoved them to ake some steps—he was not prepared at the present noment to say what steps—for instituting high chools for imparting commercial knowledge. Many oped that in the newly-constituted University of ondon there might, at any rate, be formed a high chool of economics and of commercial knowledge. ll he would say was this, that if they desired that uch a school should be established in London, they nust not show apathy or be neglectful of their own nterests, but must take such measures as were ecessary to impress generally upon the public the necessity of such a school being established. It was in the direction of a school of a university character that we in this country showed the greatest need of further development.

Mr. F. A. Ludwig said he had been much interested in this paper because, though a naturalised Englishman, he was born in Germany, and was educated at Frankfort. When he came to England in 1883, he was much struck by the very low standard of education amongst city clerks; he often talked to them about subjects respecting which he found they knew nothing, and their reply would be that they only wanted to know figures, and how to write a letter, and that £ s. d. were the letters they were most interested in. He was much struck at the great success the English nation had achieved with such a very limited education, but they were beginning to see now that the continental countries were going ahead. In Germany, every one was bound to go to school, and all young men who wanted to get off with one year in the army, instead of three, had to pass a certain standard of education to which very few young men in the city of London would be equal. One thing, however, which the German had in his favour was the cost of education, a great portion being borne by the Government. For the highest schools they paid only £7 10s. a year, and had the very best teachers. In England, as he gathered from some of his friends, they had to pay much more, and, as far as he could understand, much more attention was paid to tennis and football, and more prizes were given for those sports than for education. He thought this was a mistake; there should be less attention paid to sport, and more to teaching.

Prof. W. H. H. Hudson said the future of commercial education really depended on the weakness in the course of secular education. No doubt the primary object of education was to train the character, and this was done by training not only one or two, but all the faculties of the human mind. The great defect in our school education was the concentration of attention upon comparatively few of the mental faculties. By that he meant the general training given in the secondary schools, not the tertiary training. The faculties mainly insisted on in our schools were those of memory and imitation. These were valuable, but other faculties were neglected. He thought that memory could be better cultivated by learning selections from the great poets and foreign writers. To learn a proposition from Euclid was the wrong use of memory, and did not assist education at all. The imitative faculty should be properly educated by the arts, to begin with—handwriting, drawing, painting, and such things—and, to a comparatively slight extent, in scientific subjects. It was the predominance given to language teaching which was at the bottom of the mistaken notion that the only way to learn things was by imitating people or learning

by heart. He should like to see less of imitative work and more of observational work, and children taught to draw inferences from what was put before them. Nothing was better than elementary science for teaching, and there should be introduced into the curriculum of secondary schools, such subjects as botany, geology, and chemistry, but not all at once. Sir Albert had mentioned a large number of subjects which should be introduced, but it was to be hoped he did not mean they were all to be done at once. Certain subjects should be taken up at particular times, and then dropped to make way for other subjects when they had served their purpose. For the devolopment of the reasoning faculty, there was nothing better than mathematics. A great mistake was made in many schools in not teaching mathematics as an exercise of reasoning, but only in obedience to authority. In the learning of languages, it was justifiable to use that method. To teach mathematics the pupil should see the chain of reasoning, and he was not necessarily to believe any statement merely because the teacher made it. To a large extent he attributed the failure of secondary education to the too great predominance given to languages. A great number of clever little boys at the present moment, from 9 to 12 years of age, were now struggling with three languages—French, Latin, and Greek, and many were learning German as well. Parents were ambitious that their children should obtain scholarships at the public schools, and it was this insistence that caused so much of the time of the boys to be spent in learning these subjects to the neglect of others.

Mr. H. MACAN said he was, in respect to one important point on the side of the Philistines. The Bishop of London, the other day, remarked that the successes of Englishmen in the past had been in a great measure due to the fact that while other people talked about a thing and made beautiful suggestions, Englishmen somehow had a knack of going and doing. As he was coming to the meeting, he bought an evening paper with an account of the football match between Oxford and Cambridge, and read it with great interest ; and when he heard Sir Albert Rollit say, as he did both at the Mansion House and that evening, how very superior some mild Hindoos were to young Englishmen in the number of marks they obtained in the examination of the Chamber of Commerce, and when he heard him mention a certain commercial academy where the pupils continued their studies until nine p.m., he could not help wondering whether those youths ever distinguished themselves in the football field, and whether it would be better for England in opening up the great continent of Africa, and in winning such victories as Omdurman, that she should have boys who got 10 or 20 per cent. more marks in an examination or boys who could play in football matches such as had taken place that day. They heard a great deal about the advantages of a general education and of secondary education as preparatory to commercial education, but they found that the boys who took prizes in public examinations and who did particularly well when they came into counting-houses, according to the verdict of practical men of business, were those who had been prematurely specialists in commercial education. He had not the slightest doubt that any practical man going over the apprentices in a business house and seeing which wrote the boldest hand, which did his tots and totals best, which was the sharpest at book-keeping, shorthand, typewriting, and the various other things which were appreciated, would find that they were those who had not had the chance of secondary education, but had been prematurely specialised. He quite agreed that that was all wrong, but he did not think business men had yet fully appreciated that point. A passage from the report of the consul at Stettin was quoted by Lord Reay, and had been quoted all over the country, that it was believed that the Germans beat us because of their superior commercial education, but that was not true; the reason was because of their superior general education, but there was a footnote to that passage, not generally quoted, which explains that by that the consul did not mean primary education, but the *realschule* ; that kind of education which the late President of the Naitonal Union of Teachers spoke of in his presidential address in Wales two years ago, when he said that if secondary education remained unorganised very much longer, the county councils with their *realschule* would solve the problem themselves. As one who had been solving this problem, who in the last few years had founded five or six schools of this type, giving a complete commercial education, at one of which he had been present that afternoon at the distribution of prizes, he might say to Sir Albert Rollit that if he sometimes had a little time to spare, when he was not visiting those valuable schools abroad, and would condescend to come to some of the smaller towns where such schools had been founded by the county councils, he would find that secondary education had set in and was already very far advanced. He regretted very much that whenever commercial education was discussed there was always this reference to the prospects of legislation in the coming Session. Sir Albert Rollit had made a remark which was echoed by the Chairman about a certain compromise which had been arrived at, but that compromise failed in one important point, because the senior partners, the persons who had the money at the present time, and were organising secondary education, had not been consulted, and he would venture to remark that unless they agreed to the compromise, the Secondary Education Act, which was so much desiderated would not take the direction they had been led to expect.

Mr. J. S. THORNTON said no one could be better fitted to deal with this subject than Sir Albert

ollit, who was every day meeting commercial men. doing so he must have formed the highest opinion the value of initiative, and of the masterfulness and ower of the individual in British commerce. He ould, therefore, venture to expostulate with him and ith the Chamber of Commerce for acting somewhat consistently, and blowing both hot and cold. That ery masterfulness and individualism which they raised and exalted in commerce, they were determined to stamp out in the field of general education, nd he veutured to say that if they did so the loss to ngland would be terrible; much more terrible than the Chamber of Commerce and leaders in politics were ware of. Sir Albert had spoken with pride of the olytechnics springing up all over London and elsewhere, and of day schools in connection with them, ut both he and the Chairman skilfully avoided any mention of the higher grade schools, 56 of which in London were very soon to become secondary schools. What would be the result? The Polytechnic day chools charged £3 a year, one-fifth of the prime ost; and these commercial schools, which were eally secondary schools in connection with Board chools, although under no statutory authority would ive the education free. What would the cotton spinners of Manchester, or the woollen manufacturers of Yorkhire say if the Government proposed to come in and pin wool at one-fifth the prime cost? It was said that when great improvements were introduced somebody must suffer, the good of the majority must be considered, and that some suffering to individuals was unavoidable. But it was not necessary that the good private schools of this country should go to the wall. If the present arrangements were to continue, however, not only the bad schools would go to the wall (of which they would all be glad), but the good schools would go too, because no private school could exist with such competition as that. But such an evil was quite unnecessary. Who started local examinations? The University of Oxford sometimes said they did, but Sir Henry Wood had said in that room that the Society of Arts was before the University of Oxford; and he would add that the private schoolmasters of England were before the Society of Arts, and they were the most successful in the work; they examined sometimes more than the two universities put together. The college they founded was examining 15,000 pupils annually, and he said they could not afford to do without the private initiative in education which showed such results. He would therefore expostulate with the Chamber of Commerce when they said that not a penny of public money should go to any private school however good the condition of that school might be. That was a false and fatal policy. He should like Sir Albert Rollit to visit Copenhagen and Christiania, and see the very excellent Trade schools and Trade gynmasia there, where from 150 to 250 young men and 72 young women were being trained in commerce and were acting as very capable clerks. In Denmark three-fourths of the secondary schools which were recognised by the State were private schools, and in Norway three-sevenths, and the same thing was found in Sweden and Finland.

Mr. T. A. BAKER said he wished, if possible, to emphasize the importance of this question of commercial education from a practical point of view, by giving some instances showing how we were being beaten in commerce for want of knowledge in business men. Sir Albert had referred to the early commercial school in Lisbon, founded by the Marquis Pombal; only last month he happened to be in Lisbon, and there noticed the lack of commercial education in Englishmen. He went with a friend into a place of business to make some purchases, and found that the goods they were shown were not made in Manchester as they expected, but in Bohemia. His friend, however, noticed some other goods, which he said he was sure were English, because they were marked in yards, and priced in shillings. Whilst looking at them a gentleman stepped up and said they were not for sale; they were his samples. It appeared that he was a traveller for a Manchester house, but he was not an Englishman; he was a German. In Oporto, he came across another traveller for a Manchester firm, who was an Englishman, but he soon found on going about with him in the town that he was very imperfectly conversant with Portuguese. It was pretty plain that he would not be likely to gain, or even retain, much business; whereas the German, who knew Portuguese as well as English thoroughly, in a year or two would be starting in business for himself and selling German goods. This question of languages was very important, and it was quite easy for children to learn three or four languages when they were young. At the Antwerp school all the pupils had to correspond in three languages. In Scotland recently he met a gentleman who travelled for a jute house in the East, who spoke six or seven languages, and who was then learning Roumanian, but he feared there were not many English travellers who were similarly qualified. The great mass of our trade was being passed over to Germany. That afternoon he had been talking to Mr. Fraser, who had just returned from a cycling tour round the world, and he asked him if he had met a single English commercial traveller who could speak three or four languages, and he said he had not. It was very rarely you found an Englishman who did not get into a muddle with foreign money. The decimal system certainly ought to be taught in England. Some years ago he published a little book entitled "Our Foreign Competitors." It was written for English people, but they did not take very much notice of it. In the Antwerp University, however, it was seized hold of as a text-book, and read once a week. A very good feature of that University was the travelling scholarships, which he should like to see introduced into England, so that a young man might have his *wanderjahr*, and go abroad and study the commerce of other countries. Commercial geography

was of immense importance. The French had seized a great deal of the country on the West Coast of Africa which was thoroughly well known out there as the "Bristol coast," because the Bristol merchants worked up the trade there; and if that had been known throughout England he doubted if France would have been allowed to appropriate it. In Sweden and Finland education had made marvellous strides. He was travelling there recently with an engineer, who told him that in engineering the Swedes were ahead of us, they were working steam-engines with a pressure of 3,000 lbs. to the square inch. In Finland, he was told that the people in London had no idea what electricity and telephones could do, and although he was a little sceptical at first, in Helsingfors he found they were really far ahead of us. Not long ago he had a request from a small town in Austria, of about 5,000 inhabitants, for some articles for the English club; he was rather surprised, and on inquiry found that there was not an Englishman in the place, but they had a club in which nothing but English was spoken, and only English songs were sung. He should like to know if there was any small town in England in which there was a club in which only German and French was spoken. In conclusion, he thought the system of having commercial attachés would be of benefit, but they should not be young men fresh from a university, nor yet those who had failed in business, but thoroughly educated men, with practical and successful business experience.

Mr. F. Oldman, while he fully appreciated the merits of the paper, thought Sir Albert had covered rather too much ground, and would have done better to confine himself to a description of the methods by which commercial education could be systematised and made of greater value. He thought he had rather underestimated the facilities which already existed, and that it was a mistake to divorce commercial from technical education. The latter had taken a great hold on public imagination, and what was chiefly wanted was to direct the enthusiasm which already existed to some extent in favour of technical education towards commercial ends. Commercial education, of an elementary and intermediate type, was already largely supplied by the municipal authorities.

Sir Albert Rollit, in reply, said he had never suggested any divorce from technical education, nor had he failed to realise what technical schools were doing; on the contrary, he had been to several lately, and was fully conscious of the value of their work. But the commercial side had not been developed, and his object had been to stimulate that by every means in his power. With regard to what Mr. Macan had said as to the compromise, it was true that county councils would have to be consulted. The cleft between county and non-county boroughs had been made up, and on the following day he had to attend a meeting of county councils representatives, when he hoped that all differences of opinion would be bridged over, and that the result would be the Bill to which he had already referred. Mr. Thornton was mistaken in supposing that the Chamber of Commerce had opposed the efforts of private schoolmasters, for so far from having refused aid to work, wherever it was done, the object had been to strengthen the modern sides of schools. This involved the recognition of private as well as public schools. He had not been to Sweden, but he had seen the school in Copenhagen, which he considered an excellent one. In the matter of special machines for special purposes they were being run very close indeed by Sweden and the United States, and this was a reason why they should improve technical education, and also the means of securing the best sale of the machines in question. He most thoroughly reciprocated what had been said by the Chairman as to the work of the University of London, and he thought he had referred to the necessity of a commercial college in many of the large commercial centres. With this object in view he had pressed on the Senate of the University of London the desirability of recognising engineering as a faculty, and he thought that economics and commerce might also be recognised.

Miscellaneous.

RICE CULTIVATION IN RUSSIA.

While rice has long been grown in Persia and the Transcaucasus, it was almost unknown in the interior of Russia up to 1886, the supply being imported from India and subjected to a high duty, which confined its use to the wealthier classes. The Russians commenced its cultivation in the early eighties, and in 1888 the first rice-cleaning steam factory was opened in Baku, producing 100,000 pouds (1,612 tons) the first year. According to Consul-General Holloway of St. Petersburg, there has been a steady increase in the production, and there are now five rice-cleaning steam factories in operation, with an annual production of 3,000,000 pouds (48,387 tons). An additional factory is now in course of construction which is to be supplied with the most improved machinery. The demand for rice is increasing, and it is now generally used by the peasants throughout the empire, the quality of the native product being equal to that of the imported article. The residue are utilised, the broken grain being made into starch while the flour is given to hogs. The finished product is packed and sold in jute bags, the four grades being marked as follows:—"Reshta," having a small round grain; "Alalau," large round grain; "Campa," a thin and short grain, and "Sedra," a long and thin grain, which is considered the best. In the Caucasus, the Transbaikal, and Turkestan regions, rice is sown in the same way as wheat. The producers ship uncleaned rice to the ports of the Caspian Sea, where

is sold to middlemen and commission agents. The ices are controlled by the supply and demand. uring latter years the annual export of rice from iku amounted to 3,000,000 pouds (48,387 tons), ing valued at 4,500,000 roubles (£450,000). The incipal consuming markets are Warsaw, Lodz, the istula region, St. Petersburg, Riga, Moscow, Kief, harkof, and on the Volga, Astrakhan, Nizhni ovgorod, Saratov, Tsaritsine, and Samara.

Correspondence.

TRANSMISSION OF ELECTRIC POWER.

Professor GEORGE FORBES writes:—Since my iper was read on the 23rd November I learn that e great advantage of raising a mortgage on the ppper used for long-distance transmission of electric ower had been referred to in 1892 before the Man-iester Association of Engineers by Mr. B. H. hwaite. The African Concessions Syndicate, writing om 120, Bishopsgate-street, inform me that a con-ssion was eventually granted to them for the water-ower of the Victoria Falls and the Zambesi River on e 17th December, 1896. My paper had led people to ink that the negociations for such concession were *rmanently* closed by the troubles in 1895-6 in hodesia.

Obituary.

SIR WILLIAM ANDERSON, K.C.B., F.R.S.—Sir Villiam Anderson, whose death occurred at his ficial residence, Woolwich Arsenal, on Sunday, th inst., was a prominent member of the Society Arts, and a member of the Council from 1885. is association with the Society was more than ficial, for he contributed several valuable com-unications to its records. His Howard Lectures on e "Conversion of Heat into Useful Work," delivered 1884-85, have since been republished, and are now recognised text-book on the subject. Subsequently read papers on the "Purification of Water by on," on "Aluminium, and its Manipulation by e Deville Castner Process," &c. He was a frequent tendant at the evening meetings, and was chairman several occasions. He was a member of Council om 1885 to 1888, Vice-President from 1889 to 1892, reasurer in 1893, and Vice-President from 1894. e was also an active member of the committee hich carried out the Society's motor trials in 1888.

Sir William Anderson was born in St. Petersburg, nuary 5, 1835, and was educated at the High ommercial School, where he was head of the school d silver medallist, and had conferred upon him the freedom of the city of St. Petersburg. Subsequently he matriculated at King's College, London, and became a pupil of Sir William Fairbairn in Manchester. From 1855 to 1864 he was in partnership with Messrs. Courtney and Stephens in Dublin, and in 1863 he was President of the Institution of Civil Engineers of Ireland. On his return to London in 1864 he joined the firm of Easton and Amos, of which—under the style of Easton and Anderson—he later became head. In 1889 he was appointed Director-General of the Royal Ordinance Factories by Mr. Stanhope, then Secretary of State for War, and in 1897 he was created a Knight Commander of the Order of the Bath. He was a Vice-President of the Institution of Civil Engineers, and Past President of the Institution of Mechanical Engineers; in 1889 he acted as President of Section G of the British Association.

PROF. T. HAYTER LEWIS.—Mr. Hayter Lewis, who died at his residence in Kensington Gardens-square on Saturday, 10th inst., was elected a member of the Society of Arts in 1868. He was born in London on July 9, 1818. He was a student of the Royal Academy in 1837, and in 1839 he obtained a silver medal for architectural drawing. He was a pupil of Sir William Tite, and in 1854 he designed the Panopticon in Leicester-square (afterwards converted into the Alhambra Music-hall). In 1865 he was appointed Professor of Architecture at University College, and afterwards designed additions to the College buildings. He resigned his professorship in 1881, and was elected Emeritus Professor. He was chairman at the Society's evening meetings on several occasions when matters connected with architecture were discussed.

General Notes.

PAINTERS' COMPANY.—The Painters' Company offer a travelling studentship of fifty pounds for the encouragement of the study of decoration. This is open to competition by students between the ages of 20 and 35, in any recognised school of art or other institution devoted to the study of applied art in any form and situate within the limit of the larger metropolitan postal area. Particulars may be obtained from the clerks, Painters'-hall, 9, Little Trinity-lane, E.C.

FOREST PRESERVATION IN BOHEMIA.—Bohemia is one of the most populous countries in the world, its climate is relatively cool with rather severe winters, and therefore much fuel is used, which is largely taken from the forests covering the mountain sides. Yet after the many centuries during which these forests have furnished fuel and building material for a dense population, they retain nearly their original area. This, says Consul Mahin, is due to the forethought

of the Government in ordaining that as trees were cut down others should be planted to fill the vacancies. Vast stretches of dense forests cover the mountain slopes; the wood is mostly pine. Trees are constantly being cut, but wherever a clearing is made small trees are planted the next spring. What at a distance may appear to be a bare spot in the forest, on a nearer view is found to be covered with little trees set out in symmetrical rows, and varying in height according to the length of time since they were planted. The new trees are raised from the seed in small enclosures scattered in the mountains, and are thence transplanted.

MEETINGS OF THE SOCIETY.

JUVENILE LECTURES.

Wednesday evenings, at 7 p.m. Two Lectures by PROFESSOR F. JEFFREY BELL, M.A. (of the Department of Zoology, British Museum):—

January 4.—"Hands and Feet."

January 11.—"Some Ways in which Animals Breathe."

ORDINARY MEETINGS.

Wednesday Evenings, at 8 o'clock:—

Papers for meetings after Christmas:—

"Tuberculosis in Animals." By W. HUNTING.

"Canals and Inland Navigation in the United Kingdom." By L. F. VERNON-HARCOURT, M.A.

"Preservation of Timber." By S. B. BOULTON.

"Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

"Leadless Glazes." By WILTON P. RIX.

"London Water Supply." By WALTER HUNTER, M.Inst.C.E.

"Maiolica." By W. BURTON.

"Wrought Iron Signs." By J. STARKIE GARDNER.

"Vitreous Enamels." By CYRIL DAVENPORT.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday afternoons, at 4.30 o'clock:—

January 19, February 9, Maich 9, April 13, May 11, 25.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons, at 4.30 o'clock:—

January 24, February 28, April 25.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings at 8 o'clock:—

January 31, February 21, March 14, April 18, May 2, 30.

CANTOR LECTURES.

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.
January 16, 23, 30, February 6.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC 19...British Architects, 9, Conduit-street, W., 8 p.m. 1. Mr. H. R. J. Burstall, "The Application of Electric Power to Practical Purposes in Buildings." 2. Mr. Bernard M. Drake, "Some Practical Hints on the Production and Use of Electricity for Lighting Country Houses."
Actuaries, Staples-inn-hall, Holborn, 7 p m.
London Institution, Finsbury-circus, E.C., 5 p.m. Dr. W. J. Russell, "How to Produce a Picture on a Photographic Plate in the Dark."

TUESDAY, DEC. 20...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. Francis Fox's paper, "The Ventilation of Tunnels and Buildings." 2. Mr. John Handsley Dales, "High-Speed Engines."
Pathological, 20, Hanover-square, W., 8½ p.m.
Photographic, 12, Hanover-square, W., 8 p.m. (Photo-mechanical Meeting.) Mr. E. Sanger Shepherd, "Some Colloid Printing Methods."

WEDNESDAY, DEC. 21...Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Capt. A. Carpenter, "The West Indian Hurricane, September, 1898." 2. Mr. W. H. Dines, "The Connection Between the Winter Temperature and the Height of the Barometer in North Western Europe."
Geological, Burlington-house, W., 8 p.m. 1. Mr. E. T. Newton, "A Megalosauroid Jaw from Rhætic Beds near Bridgend, Glamorganshire." 2. M. M. Ogilvie [Mrs. Gordon], "The Torsion-Structure of the Dolomites." 3. Prof. J. B. Harrison and Mr. A. J. Jukes-Browne, "The Oceanic Deposits of Trinidad, W.I."
Microscopical, 20, Hanover-square, W., 8 p.m. Exhibition of Binocular Microscopes.
Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Mr. Alfred James, "Notes on a Process for Treating Slimes without Filtration or Decantation." 2. Dr. A. L. Simon, "Notes on Fouche's Aëro-Condenser." 3. Mr. Walter McDermott, "The Tin Mines of Bolivia." 4. Mr. Malcolm Roberts, "Minerals found in the Silver Lodes of Tatasi, and Portugalete, Bolivia."

THURSDAY, DEC. 22...Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. S. Evershed, "Telegraphy by Magnetic Induction." 2. The discussion on Dr. Lodge's paper, "Impovements in Magnetic Space Telegraphy," and on Mr. Evershed's paper, will be opened by Dr. Fleming and Mr. Preece, with experimental demonstrations.

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FRIDAY, DECEMBER 23, 1898.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, 1899, at 7 o'clock, by Professor F. JEFFREY BELL, M.A. (of the Department of Zoology, British Museum). The first lecture will be on "Hands and Feet," and the second lecture on "Some Ways in which Animals Breathe." The lectures will be fully illustrated with lantern slides.

The lectures will commence at 7 o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each member is entitled to a ticket admitting two children and an adult. Members requiring these tickets should apply at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

ACETYLENE.

By Vivian B. Lewes,

Professor of Chemistry, Royal Naval College, Greenwich.

Lecture I.—Delivered November 21, 1898.

At a meeting of the Royal Dublin Society in March, 1836, Edmund Davy, who was at that time Professor of Chemistry to the Society, first described acetylene gas and experimentally demonstrated some of its more remarkable properties. In the autumn of that year, at the Bristol meeting of the British Association, he read a paper upon it and the method of production, showing that when the metal potassium was made by heating a mixture of calcined tartar and charcoal in a large iron bottle, a black substance was frequently formed which was readily decomposed by water and yielded a gas which we now know as acetylene, but which he at that time christened bicarburet of hydrogen. It was in this paper that the author pointed out that from the brilliancy with which the new gas burnt in contact with the atmosphere, it was admirably adapted for the purpose of artificial light, if it could be produced at a sufficiently cheap rate.

Twenty years elapsed after Davy's discovery before any important addition was made to our knowledge of acetylene, and although Quet and Boettger made some observations on the formation of metallic acetylides in 1857, it was not until Berthelot's classical researches upon this compound, extending from 1859 to 1862, that anything was definitely known as to its true composition and method of formation.

It was Berthelot who showed that acetylene was formed during the decomposition of many organic substances by heat, and that ethylene, methane, alcohol, and ether, all yielded this compound when passed through heated tubes, and that it was therefore almost invariably found in the products of the destructive distillation of organic compounds, whilst he finally demonstrated the possibility of synthesising acetylene by passing the electric current between carbon points in an atmosphere of hydrogen.

Acetylene has shared with many other bodies the troubles incidental to the constant changes of nomenclature which have occurred during the past century. Christened bicarburet of hydrogen by its discoverer, it soon after became known as klumene, whilst at a much

later date the name acetylene was bestowed upon it, being derived from the hypothetical radical acetyle (C_2H_3), to which acetylene bears the same relationship as ethylene (C_2H_4) does to the radical ethyle (C_2H_5). It was also proposed at one time to give it the name of ethine, but the name which has survived the diseases common to incipient nomenclature is that of acetylene, by which it is now universally known.

On analysis this gas is found to contain:—

Carbon	92·3
Hydrogen	7·7
	100·0

It has a density of 0·92, and when prepared by the action of water upon calcic carbide, it has a very strong and penetrating odour, but when the gas is thoroughly purified from sulphuretted and phosphuretted hydrogen, which are invariably present with it in minute traces, this extremely pungent odour disappears, and the pure acetylene has a not unpleasant etherial smell.

Acetylene is readily soluble in water, which at normal temperature and pressure takes up a little more than its own volume of the gas, and yields a solution giving a purple red precipitate with ammoniacal cuprous chloride and a white precipitate with silver nitrate, these precipitates consisting of acetylides of the metals. The solubility of the gas in various liquids, as given by different observers, is:—

100 volumes of		Volumes of acetylene.
Brine	absorb	5
Water	,,	110
Alcohol	,,	600
Paraffin	,,	150
Carbon disulphide	,,	100
Fusel oil	,,	100
Benzene	,,	400
Chloroform	,,	400
Acetic acid	,,	600
Acetone	,,	3,100

It will be seen from this Table, that where it is desired to collect and keep acetylene over a liquid, brine, *i.e.*, water saturated with salt, is the best for this purpose, but in practice it is found that, unless water is agitated with acetylene, or the gas bubbled through water, the top layer soon gets saturated, and the gas then dissolves but slowly.

The great solubility of acetylene in acetone was pointed out by MM. Claude and Hess, who suggested charging acetone with the gas under pressure, a litre of acetone dissolving 360 times its own volume of the gas under a pressure of 12 atmospheres. On relieving the pressure the gas again escapes, and it was thought that this would prove a better method of storing the gas than liquefying it, but experiment has shown that acetone saturated in this way under pressure shares many of the disadvantages of liquid acetylene itself.

When acetylene was first introduced on a commercial scale, grave fears were entertained as to its safety, it being represented that it had the power of combining with certain metals, more especially copper and silver, to form acetylides of a highly explosive character, and that even with coal gas, which contains less than 1 per cent. of acetylene, such copper compounds had been known to be formed in cases where the gas distributing mains were composed of copper, and that accidents had happened from this cause. It was therefore predicted that the introduction of acetylene on a large scale would be followed by numerous accidents, unless copper and its alloys were rigidly excluded from contact with the gas. These fears, however, have fortunately proved to be absolutely unfounded, and the original gas-fittings can be used with perfect safety with this gas.

In the summer of 1895, Mr. H. Gerdes, the chief engineer of Messrs. Pintsch, of Berlin, made an exhaustive series of experiments upon this point, not only with the gas under ordinary pressure, but with mixtures of acetylene with oil and coal gas at pressures of nearly 10 atmospheres.

This was done by placing the metals to be tested in steel cylinders, the slips being fitted in wooden frames so arranged as to prevent any contact either between the individual metals or the walls of the metal cylinder. Two of these cylinders were filled with pure acetylene, two with a mixture of 80 per cent. of acetylene, and 20 per cent. of oil gas, and one with a mixture of acetylene with 20 per cent. coal gas, a small quantity of water being placed into each cylinder in order that the gas should be moist, as it was expected that this would greatly facilitate the action upon the metals. These cylinders were filled with the gases at a pressure of nine to ten atmospheres, and they were exposed on the roof of a shed from July 18, 1895, to April 9, 1896, this range of time exposing them to the highest temperature of an exceptionally hot summer, and the lowering of temperature incidental to a very cold winter.

Of all the metals and alloys used, those which are known to resist ordinary oxidation in the air remained perfectly unaffected, whilst the easily oxidisable metals suffered on the surface, but in no instance was it possible to trace any acetylene compound, and no explosion could be produced by either heating or hammering, whilst further experiments with acetylene, ammonia, and water showed clearly that such corrosion as had taken place by the simultaneous action of ammonia gas and acetylene was due exclusively to the action of the former gas, and no explosive compounds were formed.

If acetylene be passed through an ammoniacal solution of cuprous chloride, copper acetylide is formed, and when dry this explodes with great violence when struck or when heated, and independent observations, made by M. Bullier at about the same period, showed that in order to obtain this explosive compound of acetylene and copper, it was necessary that the gas should come in contact with a sub-salt of the metal in the presence of excess of ammonia, and as in actual practice these conditions would never be realised, it is manifest that the alleged danger may be disregarded.

Acetylene shows some extremely interesting actions with regard to other metals. If acetylene be passed over red hot sodium or potassium, these metals burn in the gas with the formation of carbides, which on being brought into contact with water, decompose with explosive violence, again setting free acetylene, whilst Moissan and Mourreu have made the interesting observation, that with certain metals in the spongy condition, strong action takes place with acetylene, and that if this gas be passed over reduced iron which has been prepared at as low a temperature as possible, bright incandescence is produced, and carbon is copiously deposited and quickly chokes the tube, hydrogen at the same time appearing as a gaseous residue.

The second drawback that has always been urged against acetylene in its early days was that it was a highly poisonous gas, the researches of Bistrow and Liebreich having apparently shown that it acted upon the blood in the same way that carbon monoxide did to form a stable compound. Experiments upon the toxic action of gases, however, are open to considerable error, partly depending upon the method by which the gas has been prepared, and which will affect its purity, and partly upon the nature of the animals upon which the experiments are tried, rabbits and other rodents resisting the action of gaseous poisons like carbon monoxide far better than carnivorous animals, such as dogs, and it is impossible to argue from the action of the gas upon the one what the action will be upon the other, whilst it has not yet been made clear that the action upon either is a very safe index as to the action of the gas upon man.

Very extensive experiments, however, made by Drs. Grehant, Brociner, Malooz, Crismer, and others, all conclusively show that acetylene is much less toxic than carbon monoxide and, indeed, than coal gas.

Acetylene gas can be condensed into the liquid state by cold or by pressure, and the experiments by Ansell show that if the gas be subjected to a pressure of 21·53 atmospheres at a temperature of 0° C. it is converted into the liquid state, the pressure needed increasing of course with the rise of temperature, and decreasing with the lowering of the temperature, until at 82° C. acetylene becomes liquid under ordinary atmospheric pressure.

The critical point of the gas is 37° C., at which temperature it requires a pressure of 68 atmospheres to liquefy it, whilst immediately that temperature is passed no pressure that could be brought to bear upon it will convert it into the liquid state. This phenomenon, which is common to all gases, of resisting all efforts to liquefy them above a certain temperature, was first investigated by Andrews, and the resolution of liquid acetylene into a gas on reaching its critical point can be very beautifully illustrated by taking a small tube half filled with the liquid and projecting an image of it upon the screen. On now gently warming the tube the meniscus of the liquid, which at first was perfectly clear, is seen to flatten itself, and in a few minutes to entirely disappear as the temperature passes the critical point. On now removing the source of heat and allowing the tube to cool, as soon as the critical point is again reached on the downward scale, a violent storm of acetylene rain is seen to be going on in the tube as the gas condenses to the liquid state once more.

Long before the discovery by Willson of the method of making calcic carbide on a commercial scale had placed acetylene at every experimentalist's disposal, acetylene had been liquefied by Cailletet, Andrews, and Ansell, but with the advent of calcic carbide, liquid acetylene assumed a position of commercial importance, and Messrs. Dickerson and Suckert, seeing the business possibilities,

made it on a fairly large scale, and kept it in steel cylinders, whilst some time afterwards Pictet also set up the manufacture of the liquid.

A great future was expected from its use in this condition, as a cylinder fitted with the necessary reducing valves would supply the gas to light a house for a considerable period, the liquid occupying between one four to five-hundredth the volume of the gas, but in the States and on the Continent, where liquefied acetylene was made on a large scale, several fatal accidents occurred owing to its explosion under not easily explained conditions.

As a result of these accidents Berthelot and Violle made a very valuable research upon the explosion of acetylene under various conditions, and they found that if liquid acetylene in a steel bottle were heated at one point by a platinum wire raised to a red heat, the whole mass decomposes and gives rise to such tremendous pressures that no cylinder would be able to withstand them, these pressures varying from 71,000 to 100,000 lbs. per square inch. They, moreover, tried the effect of shock upon the liquid, and found that the repeated dropping of the cylinder from a height of nearly 20 feet upon a large steel anvil gave no explosion, but that when the cylinder was crushed under a heavy blow, the impact was followed, after a short interval of time, by an explosion; but this was manifestly due to the fracture of the cylinder and the ignition of the escaping gas, mixed with air, from sparks caused by the breaking of the metal, and a similar explosion will frequently follow the breaking in the same way of a cylinder charged with hydrogen at a high pressure.

Continuing these experiments, they found that in acetylene gas, under ordinary pressures, the decomposition brought about in one portion of the gas, either by heat or the firing in it of a small detonator, did not spread far beyond the point at which the decomposition started, but was local; whilst, if the acetylene was compressed to a pressure of more than 30 lbs. on the square inch, the decomposition travelled throughout the mass and became, in reality, detonation.

These results showed clearly that liquefied acetylene was far too dangerous for general introduction for domestic purposes, as, although the occasions would be rare in which the requisite temperature to bring about detonation would be reached, still, if this point were attained, the results would be of a most disastrous character; whilst the fact that several accidents had already happened accentuated the risk, and in this country the storage and use of liquefied acetylene is prohibited.

When liquefied acetylene is allowed to escape from the cylinder in which it is contained into ordinary atmospheric pressure, some of the liquid assumes the gaseous condition with such rapidity as to cool the remainder below the temperature of $-90°$ C., and converts it into a solid snow-like mass.

Acetylene has the property of inflaming spontaneously when brought in contact with chlorine gas, and if a few pieces of carbide be dropped into saturated chlorine water the bubbles of gas as they reach the surface spontaneously catch fire, whilst if a jet of acetylene be passed up into a bottle of chlorine it takes fire and burns with a heavy red flame, depositing its carbon in the form of soot. If chlorine be bubbled up into a jar of acetylene standing over water a violent explosion, attended with a flash of intense light, and the deposition of carbon at once takes place.

When acetylene is kept in a small glass holder exposed to direct sunlight, the surface of the glass soon becomes dimmed, and Mr. Bone has shown that when exposed for some time to the sun's rays it undergoes certain polymerisation changes which lead to the deposition of a film of heavy hydrocarbons on the surface of the tube. It has also been observed by Cailletet and later by Villard that when allowed to stand in the presence of water a solid hydrate is formed.

Acetylene as has been shown is readily decomposed by heat, polymerising under its influence to form an enormous number of organic compounds. Indeed acetylene which can itself be directly prepared from its constituents, carbon and hydrogen, under the influence of the electric arc, can thus really be made the starting point for the construction of an enormous number of different organic compounds of a complex character.

Acetylene in contact with nascent hydrogen builds up ethylene, ethylene acted upon by sulphuric acid yields sulphovinic acid, and this can again be decomposed in the presence of water to yield alcohol, whilst it has been proposed to manufacture sugar from this remarkable body. Picric acid also can be obtained from it by first treating acetylene with sulphuric acid, converting this into phenol by dissolving in potash and then treating the phenol with fuming nitric acid.

Acetylene is one of those bodies the formation of which is attended with the disappear-

ance of heat, and it is for this reason termed an endothermic compound, in contra-distinction to those bodies which evolve heat in their formation and which are called exothermic. Such endothermic bodies are nearly always found to show considerable violence in their decomposition as the heat of formation stored up within them is then liberated as sensible heat, and it is undoubtedly this property of acetylene gas which leads to its easy detonation by either heat or a shock from an explosion of fulminating mercury when in contact with it whilst under pressure.

The observation that acetylene would be resolved into its constituents by detonation is due to Berthelot, who, by starting an explosive wave in acetylene by firing in it a charge of 0·1 gram of mercury fulminate, succeeded in doing this. It has since been shown, however, that unless the gas is at a pressure of more than two atmospheres this wave soon dies out and the decomposition is only propagated a few inches from the detonator.

If acetylene be heated in contact with air to a temperature of 480° C. it ignites and burns with a flame, the appearance of which varies with the way in which the acetylene is brought in contact with the air. With the gas in excess a heavy lurid flame emitting dense volumes of smoke results, whilst if the gas be driven out in a sufficiently thin sheet, it burns with a flame of intense brilliancy and almost perfect whiteness, by the light of which colours can be judged as well as by daylight.

The ignition point of the gas being below that of ordinary gas, it can be ignited by any red hot carbonaceous matter, such as the brightly glowing end of a cigar.

For its complete combustion a volume of acetylene needs approximately 12 volumes of air, and forms as its products of combustion, carbon dioxide and water vapour. When, however, the air is present in much smaller ratio, incomplete combustion ensues, and carbon, carbon monoxide, carbon dioxide, hydrogen, and water vapour are produced. This is well shown by taking a cylinder one half full of acetylene and one half of air: on applying a light to this mixture a lurid flame runs down the cylinder and a cloud of soot is thrown up, the cylinder also being thickly coated with it and often containing a ball of carbon; on now waiting a few moments to allow some air to diffuse into the cylinder and again applying a taper, an explosion, due to a mixture of carbon monoxide and air, takes place.

It is probable that when a flame is smoking badly, distinct traces of carbon monoxide are being produced, but when an acetylene flame burns properly, the products are as harmless as those of coal gas, and, light for light, less in amount.

When acetylene is mixed with air, like every other combustible gas, it forms an explosive mixture. Observers differ somewhat as to the range between which mixtures of acetylene and air are explosive, Dr. Clowes stating that any mixture containing from 3 to 82 per cent. of the gas is explosive, whilst Dr. Bunte gives a rather lower range.

These discrepancies are probably due to differences in the method of igniting the mixture, and also as to what is to be taken as explosion. A light applied to a mixture containing 3 or 80 per cent. of acetylene will propagate combustion throughout the mass, but so slowly under all ordinary conditions as not to attain to the dignity of an explosion, and for all practical purposes the explosive limit may be taken as 3·5 per cent. of acetylene, the upper limit being of no importance, as so large a volume of the gas is never likely to be present in the air. An explosive mixture of acetylene and air theoretically attains its maximum power with a mixture of about 12 volumes of air to 1 of acetylene, but in practice gives greater explosive pressures with mixtures far richer in acetylene, for reasons which will be fully discussed in a later lecture. Ordinary coal gas forms explosive mixtures between the limits of 6 and 29 per cent., and yields its maximum result with a mixture of 1 volume of coal gas to about 10 volumes of air.

The methods which could be, and have been, employed from time to time for the formation of acetylene in small quantities are excessively numerous, but, before the commercial production of calcic carbide made acetylene one of the most easily obtainable gases, the methods which were most largely adopted for its preparation in laboratories were: first, the decomposition of ethylene bromide by dropping it slowly into a boiling solution of alcoholic potash, and purifying the evolved gas from the volatile bromethylene by washing it through a second flask containing a boiling solution of alcoholic potash, or by passing it over moderately heated soda lime; and secondly, the more ordinarily adopted process of passing the products of incomplete combustion from a bunsen burner, the flame of which had struck back, through an ammoniacal solution of cuprous chloride, when the red acetylide of copper was produced, and this on washing and

decomposing with hydrochloric acid yielded a stream of acetylene gas.

This second method of its production, which was the one most usually adopted, has, however, the great drawback that unless proper precautions are taken to purify the gas obtained from the copper acetylide, it is always contaminated with certain chlorine derivatives of acetylene.

In the years 1890 and 1891 I devoted much time to trying to ascertain the various actions which take place in coal gas flames and which lead to their luminosity. The classical researches of Sir Humphry Davy first clearly showed that luminosity was due to particles of solid carbon heated to incandescence within the luminous zone, and my endeavour was to find the causes which led to the setting free of these solid particles. The gas which is supplied to us for illuminating purposes, whether it be coal gas, carburetted water gas, or oil gas, consists of a mixture of many gaseous bodies, of which hydrogen, carbon monoxide, and members of the methane and ethylene families form the largest proportion, whilst a small percentage is composed of gases such as carbon dioxide, oxygen and nitrogen, which are simply impurities.

When the homogeneous mixture of these varied constituents leaves the burner tip, and the gases find themselves in the presence of the atmosphere, they at once begin to diffuse into it with a rapidity inversely proportional to the square roots of their densities, with the result that the lightest and most abundant member of the gaseous mixture, hydrogen, finds its way quickly to the exterior, and methane soon follows. These two gases, constituting some 85 per cent. of the mixture, on meeting the air bear the brunt of the combustion, and in burning form the main portion of the sheath of complete combustion surrounding the lower part of the flame. The heavier constituents of the coal gas are naturally those least affected by diffusion, and the desertion of the hydrogen and methane concentrates them in the centre of the flame, and they flow upwards, forming the non-luminous inner zone of the flame, or as it is more often termed, the zone of non-combustion. These gases are chiefly the unsaturated and heavier members of the saturated hydrocarbons present in the coal gas, and in their upward travel the baking action of the heat from the completed combustion going on in the outer envelope of the flame causes a resolution of the more complex hydrocarbon molecules into the simpler compounds, acetylene and methane. As these i[n] turn diffuse outwards, they reach the oute[r] wall of combustion, which is undoubtedly th[e] hottest part of the flame, and just below th[e] inner side of the outer zone the acetylen[e] heated to above its temperature of decomposi[-]tion instantaneously splits up into finely divide[d] carbon and hydrogen, and the heat liberate[d] by the decomposition and by the change o[f] state of the carbon, being localised by th[e] rapidity of the action to the solid particles, s[o] augments the temperature given to them b[y] the flame, that they glow with high incan[-]descence, and form the luminous sheath whic[h] caps the inner zone of non-combustion.

Experiments made by withdrawing the gase[s] from various parts of luminous flames showe[d] that no matter what was the initial characte[r] of the hydrocarbon present, acetylene wa[s] always produced before luminosity made it[s] appearance, and moreover that the illuminatin[g] power of the flame followed the ratio of acety[-]lene so produced, and this fact, taken in con[-]junction with the observation that when acety[-]lene, free from air, is allowed to flow throug[h] a Jena glass tube heated up to a temperatur[e] of 780° C., it is decomposed with luminosity whilst the carbon set free in flowing forwar[d] through the zone of heat is perfectly non[-]luminous, formed the basis of what is now known as the acetylene theory of luminosity.

Stated in its simplest form this theory is as follows:—In the same way that the decomposition of the acetylene in flowing through a heated tube endows the carbon particles with a luminosity which the heat of the tube alone is unable to impart, so does the decomposition of the acetylene generated in a hydrocarbon flame increase the light-yielding power of the carbon particles liberated by its decomposition over what might have been the light emitted had they only been heated to the temperature of the flame itself.

When it is considered what an enormous difference is produced by a few degrees of temperature in the light-emitting power of solids heated in a flame, it at once becomes manifest that it is at least injudicious for opponents of this theory to sneer at the effect likely to be produced by such increase in temperature as is given rise to by the decomposition of acetylene.

It is perfectly well known to everyone interested in the methods employed for burning coal gas that regeneration increases the light emitted by a flame over 100 per cent., and in some cases three times that amount, and yet

he increase in the temperature of the flame lue to warming the gas and air before comustion is but a small one.

I freely admit that when I first brought this heory forward in 1895, I placed too much lependence upon the measurements of flame emperatures by the methods at our disposal or such investigations, and in so doing laid he theory open to attack, an opportunity that as taken full advantage of; but in spite of all he criticism which has been bestowed upon it, he main issue has never been shaken, and I m just as fully convinced now, as I was then, hat in all luminous hydrocarbon flames acetyene may be truly looked upon as "the mother f the luminosity."

There are conditions under which acetylene an be burnt without the development of light. f acetylene be diluted with about 92 per cent. f hydrogen or carbon monoxide, the moleules are burnt up without decomposition, and iere being no solid matter in the flame to eat to incandescence, the flame remains nonminous. This is due to the acetylene requirig a higher temperature to decompose it when is diluted than when it is pure, and the reater the dilution the higher the temperaure needed.

If burning alcohol, which in the open-air ives a faintly luminous flame, be placed under bell-jar, the temperature of the flame is wered by some of the products of combustion eing checked in their escape, and the flame ecomes absolutely non-luminous; if now oxyen be supplied to the flame its temperature ecomes greatly increased, and not only does e flame become highly luminous, but freely posits carbon on a cold surface held within whilst gas withdrawn from the interior of e flame under each condition is found to ntain acetylene.

Another very striking example of the same nd is to be found in cyanogen, a gas which s always been noted for the beauty of the se-pink flame with which its burns. Although anogen contains the same amount of carbon acetylene, and is even more endothermic, one until lately had ever thought of the ssibility of its burning with a luminous flame, s being due to the fact that the temperature cessary to break up the molecule was so far ove the heat of the flame that the cyanogen lecule burnt as a whole, and there being deposition of carbon no luminosity would ult.

f, however, the cyanogen flame be surnded with pure oxygen instead of air, a faint luminosity appears in the flame owing to the increase of temperature; whilst if the flame be surrounded by nitrogen dioxide, another endothermic compound, the temperature is so increased that the flame becomes more intense in its illuminating power than the acetylene flame itself, and yields a dense deposit of carbon and para-cyanogen to any cold surface held within it.

Miscellaneous.

METHODS OF PREPARING RUBBER.

By R. H. Biffen.

So much has been written within the last few years on the subject of indiarubber, the sources of our supply, and the possibility of acclimatizing the best-yielding trees in our colonies, that at first sight it may appear that there is little more to be said. A study of the methods in use for preparing rubber from the latex, or milk, may however be of use to many interested in the formation of plantations, especially if some attention is paid at the same time to the inaccurate statements made in some recent publications, which apparently have disregarded the valuable series of papers on the subject contained in our one journal devoted to economic botany, the "Kew Bulletin."

The methods in use at present are either the outcome of the limited experience of uncivilised peoples, or the application of experiments made without paying due attention to what is known of the chemical constitution and physical properties of latex. As a good example of the latter we may take the experiments of Morisse,* who found that coagulation was brought about in the latex of *Hevea* by the addition of alcohol, phenol, hydrochloric acid, nitric acid, sulphuric acid, calcium chloride, ferric chloride, corrosive sublimate, &c. As the outcome of these experiments, a mixture of phenol in alcoholic solution, and dilute sulphuric acid, was recommended as a coagulating agent.

The latex is, as a general rule, a thick, white fluid, composed of small particles of rubber in suspension in a clear watery solution of various substances. Unfortunately, only the latex of a few trees has, as yet, been chemically examined when fresh.

The analysis of the latex of *Hevea brasiliensis* shows that it contains:—

Rubber	32	per cent.
Proteid matter	2·3	,,
Calcium and sodium salts	9·7	,,
Resin	traces	
Water	55 to 56	,,

It is slightly alkaline to litmus paper.†

* Seeligman, Lamy, et Falconnet; "Le Caoutchouc et la Guttapercha." Paris, 1896. p. 68.

† "Le Caoutchouc," &c., p. 94.

The presence of albumin, globulin, and other proteids, has been demonstrated by Green* in some other rubber-yielding latices.

As a general rule all these substances are to be found in rubber as it is at present prepared, often with others added to bring about coagulation of the latex, and accidentally or intentionally added impurities such as bark and clay. In all cases the percentage of impurities is large, how large we shall see later, and when it is remembered that some cause a rapid deterioration of the rubber it is obviously much to the interest of those connected with the industry that a method of preparation should be adopted which would minimize them or ensure their absence.

I propose now to consider a few of the better-known varieties of rubber.

Pará Rubber is the product of *Hevea brasiliensis*, a tree which thrives in many parts of the Amazon valley, British Guiana, &c. As pointed out by Churchill† in his consular report, there is no danger of this source of supply becoming exhausted, though this is the frequent cry of companies formed for rubber-planting, usually fated for an ephemeral existence. The tapping is done with considerable care by the natives, and even should a district become exhausted, in a few years a fresh supply of trees springs up. From the planters' point of view Brazil is hardly a suitable country, for the climate is bad, it is difficult to obtain labour, and the exchange is *liable* to endless variations. The trees have, however, been introduced into Ceylon, where small plantations exist, and into other colonies.‡

The method of preparing the rubber has been so frequently described that repetition is needless; but a "translation of a valuable article on rubber of the Orinoco"§ has received so much attention of late that it requires some examination. One of its most striking errors is the following:—"As the juice contains a considerable quantity of water, the preparation of rubber consists essentially in separating the former from the latter, which is performed by evaporating the water by means of a heating process or obtaining its coagulation by certain chemical processes. Although the last system is more rapid they prefer the former, as they pretend that the rubber thus obtained is of a superior quality—a supposition devoid of all reason."

As I have already had occasion to show,‖ this statement is incorrect, for the heating continues for too short a time; ("the rubber" *is not* "dried in a few minutes") to evaporate off some 50 per cent. of water, and further there is no loss of weight until the clot begins to contract and squeeze out water. Neither is "the supposition devoid of all reason," for it is a well-known fact that the smoked rubber is far preferable to that obtained by chemical processes. A comparison of the prices of "Pará fine" and "sernamby" should be sufficient proof of this. Why it is so m[...] be made clearer from the following experiment. [...] the end of a day's work I had several litres of lat[...] left, to which an equal volume of water had be[...] added, which would not keep over night witho[...] coagulating. To this a small quantity of acetic ac[...] was added, and in a short time the *whole of it* h[...] formed a stiff curd. On pressing and drying, a porti[...] of the water exuded from this mass of sernamb[...] but it still remained full of cavities, and the prote[...] matter in it quickly decomposed, so that ultimately [...] stinking, inflated mass was obtained.

If this latex had been coagulated by smoking [...] would have yielded a wet rubber, but the subseque[...] decomposition of proteids would not have set in, f[...] the creosote contained in the smoke would have act[...] as an antiseptic and prevented decomposition, as [...] does when meat is preserved by smoking.

Then again we find, "the rubber thus prepar[...] (by smoking) acquires a darkish colour, due to th[...] particles of coal which adhere to the outer ski[...] Some people believe that this tends to improve it, bu[...] such is not the case, for it is thus impregnated with im[...] purity."* Now when these "bottles" of rubber are c[...] across, the fresh, laminated surfaces are a silvery gr[...] colour, and as each layer is exposed to the sam[...] extent to the action of the smoke it is difficult [...] account for the outer layers only being so coloure[...] The freshly cut surfaces however soon darken an[...] become black in turn, so that the explanation of ox[...] dation seems far more probable, especially when tak[...] in conjunction with the fact that the smoke is whit[...] and not black,‡ for the nuts are simply dry-distill[...] and not actually burnt. If the smoke of these heat[...] urucuri nuts is condensed it forms two layers of liqu[...] in the receiver, one a clear limpid solution consisti[...] mainly of acetic acid, the other, darker in colour, [...] creosote.

The hot vapour of acetic acid brings about t[...] coagulation of the proteids of the latex, as may easi[...] be proved by direct experiment.

A solution of alum is said to be in use for prepari[...] rubber in some parts of the Amazon valley. Moris[...] states that alum solution has no effect upon the lat[...] of Hevea species however.

The loss in the factories on making up Pará rubb[...] is as follows‖:—(1) Pará fine, 10 to 15 per cent[...] (2) Entre-fine, the carelessly smoked pieces, 15 [...] 20 per cent.; (3) Sernamby, rubber pulled from t[...] cuts on the tree and cups, coagulated by bei[...] allowed to stand, &c., 20 to 40 per cent. From the[...] data we may safely conclude that the smoking meth[...] of preparation is by far the best in use at present.

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* Green, "Proc. Roy. Soc.," 1886, p. 28.

† "Kew Bulletin," 1898, p. 241.

‡ "Kew Bulletin," 1893, p. 159.

§ "Trinidad Bulletin," 1893, No. 18, and 1897, p. 36.

‖ Biffen, "Anns. Bot." 1898, p. 165.

* "Trinidad Bulletin," 1897, p. 38.

† Compare the plate on page 757 of the "Journ. Soc. Art[...] 1898.

‡ "Trinidad Bulletin," 1897, p. 37.

§ "Le Caoutchouc," &c., p. 67.

‖ "Le Caoutchouc," &c., p. 75.

w which will be further strengthened when we npare the losses on making up other sorts of rubber.

Ceara Rubber is the product of *Manihot Glaziovii*, ree growing chiefly in the highlands of the State Ceara, Brazil. Cross is responsible for most of descriptions of the locality in which it grows, but his experience of it appears to have been limited Pacatuba, in which place its habitat is far from pical, they are not very accurate. He records it as owing at an elevation of 200 feet above sea level, ong granite boulders, in a country whose dryness s indicated by the fact that "ferns, weeds, grasses, l mosses" were absent. True, it does grow ong granite boulders, in the scantiest of soil in h localities, but it is more at home in the untains, up to a height of 3,500 feet, and even re, where there is an abundant rainfall. These ts will serve to show the wide range of conditions tree will put up with, and were it not for the allness of its yield (1 to 3 lbs. per annum) it would invaluable for introducing into many of our colonies. Coagulation is brought about either by smoking, on the Amazons, or by simply allowing the latex to on the tree-trunks or soil. The latter methods objectionable, as the rubber invariably contains ces of bark or grit. It may also be prepared by rning the latex, and pressing the resulting clots. e method is not to be recommended though, for n if the clots are cut into thin slices and exposed the heavy pressure of a mandiocca press, a con- erable per-centage of water remains in its cavities, d decomposition sets in, but not to the same extent in "Ceará scrap."

Although so impure it commands a price usually ond only to "Pará fine." The loss is from 20 to per cent., which, in inferior qualities, may even ount to 55 per cent.

Mangabeira rubber also comes from Ceará. It is product of *Hancornia speciosa*, a dwarf tree with newhat the habit of a birch. The rubber is pre- red by the addition of an excess of salt to the latex, by Strauss' method of adding alum. Even after rty days' drying in the sun it is spongy and full of ities of liquid. As might be expected, the loss on ification is enormous, amounting to from 40 to 60 cent.

By this method of coagulating with chemical gents it is impossible to get rid of the coagulated teid matter, to say nothing of the greater part of water. Morellet's* remark that "le procédé auss est ingénieux, mais les résultats de son plication sont mauvais" may well be applied to all se chemical methods, and the sooner the search for gulating agents is abandoned the better.

The only other American rubber of importance, at sent, is yielded by *Castilloa elastica*. It appears the market in a number of different forms under names of Mexican, Nicaraguan, &c. As far as know *C. elastica* is the only species of the genus yielding rubber, for the *C. Markhamia* of Collins turns out to be a *Perebea* species.*

* "Le Caoutchouc," &c., p. 64.

The latex is obtained in a rough and ready fashion by hacking a spiral channel from the crown of the tree to the ground, or by making great gashes with a machete.

Collins† has recommended a timber-scoring knife for tapping, and since then most writers have followed his lead. On experimenting with one, I found it was practically useless, as little latex exuded, possibly owing to the closure of the vessels by the drag of its edge. Stabbing with a broad-bladed knife, or with a chisel, as practised in Ceylon,‡ gives good results without much damage to the tree. In the previously-mentioned article in the "Trinidad Bulletin" (1898), there is some slight confusion as to the localities suitable for the growth of *Castilloa*. In one place (p. 122), "it will scarcely thrive in regions that are not equally suited to *Hevea spp*," which (p. 130) grow "on land which is periodically inundated, even to a depth of five feet." Then (p. 121), "the tree (*Castilloa*) avoids marshy or boggy land, and manifests a preference for warm, deep loam, or sandy soil." The latter statement is the correct one.

The most general method of preparation in Mexico is to add an extract of the leaves and stem of the moon-flower (*Ipomoea bona-nox*), and allow the mixture to stand over-night. The floating clot which forms is then pressed to remove some of the water.§ As in all these cases of preparation by "wet" methods the rubber contains large quantities of water, it loses from twelve to thirty per cent. on drying. Another method is in use in Nicaragua.‖ The latex is mixed with about three parts of water, and allowed to stand over-night, when the rubber comes to the surface in particles, which do not unite to form a solid mass. The water is then drained off from below, and the rubber particles are mixed with a fresh supply of water, and the process is again repeated. The particles are then brought into a solid mass by pressure. The latest account of this method is apparently given by Hart, in an article on the "Coagulation of Rubber,"¶ who appears to have rediscovered it. I quote it in full as I may be mistaken. "After the addition of water, the mixture is well shaken; the globules of rubber (having a lighter specific gravity than the albumenoids and proteids [*sic*] contained in the latex) will float quickly to the surface. It is found moreover that on the addition of further volumes of water and the removal of albumenoid liquors from below the floating rubber, the globules rise much more quickly to the surface."

* "Kew Bulletin," 1887, p. 13. *c.f.* "Trinidad Bulletin," 1898, p. 21.

† Collins, "Report on Caoutchouc."

‡ "Royal Botanical Gardens, Ceylon," 1898; Ser. I., No. 4, p. 30.

§ Belt, "Naturalist in Nicaragua," p. 33. Morris, "Colony of British Honduras," p. 76.

‖ "Le Caoutchouc," &c., p. 62. "Kew Bulletin," 1887, XXVIII., p. 16.

¶ "Trinidad Bulletin," 1898, p. 131.

The following criticism of this "creaming" process is given in "Le Caoutchouc et la Gutta Percha":—"Ce mode de préparation est bien rudimentaire et ne peut fournir qu'un produit de qualité inférieure, qui perd souvent plus de 50 °/$_o$, surtout lorsqu'il fraîchement préparé." *

Recently there has been some talk of extracting rubber from leaves and twigs by means of solvents, as has been done in the case of gutta-percha. A description of this latter process may therefore be of interest. It originated in the smallness of the yield of the *Isonandra gutta* trees, a tree from 25 to 30 years old, only giving 1·3 lbs. of gutta-percha when felled. The explanation of this fact is to be found in the work of De Bary,† who showed that the laticiferous system of the tree consisted of short, closed sacs. This being the case, a great many would remain unopened, and thus a considerable per-centage of the gutta-percha would remain in the bark. As the demand for gutta-percha has been large, and the supply has been obtained by felling the trees, they have become almost extinct.‡

Serullas proposes to utilise the leaves and twigs of the shoots from the old butts to extract the gum from. They are dried, treated with caustic potash to destroy colouring matters, and treated with a solvent for gutta-percha. The solvent is then distilled off and may be used again and again.

Rather more than 1 lb. of gutta-percha is said to be yielded by 30 lbs. of chopped up fresh leaves and twigs.§

For several reasons I do not think this process could profitably be applied to the preparation of rubber. The most important of these are (1) on gathering the leaves and twigs there would be an immense loss of latex, and (2) stripping trees of their foliage (the part which builds up their food supply) invariably kills them.

The direction in which research work should tend, I venture to think, is to prepare rubber free from the other constituents of latex, so that among other things, freight and customs charges on these impurities may be avoided.

Now it has been shown conclusively that the chemical constitution of latex varies with its source, so that it is improbable that any one reagent can be found capable of coagulating any given latex. Thus from the fact that acetic acid coagulates the latex of certain Hevea species, it cannot be argued that it will coagulate the latex of a Kicksia species.

Then expert opinions, as we have seen, show that the preparation of rubber by these chemical means is not satisfactory, for the product is far from pure.

I have recently succeeded, however, in preparing pure rubber by a physical process, and so demonstrated that chemical methods are not necessary.

* "Le Caoutchouc," &c., p. 62.

† "Comp. Anat. Phan. and Ferns," p. 151.

‡ Serullas, "Kew Bulletin," 1891, ccxiii., p. 230.

§ "Kew Bulletin," ccxiv., p. 231.

This is effected by centrifugalizing the latex i[n a] special form of separating machine, when the rub[ber] particles, which have a smaller specific gravity t[han] the medium in which they are suspended, are thro[wn] out of the bowl in an almost dry state. They [may] then be converted into a solid mass by slight press[ure], or by draining off the small quantity of water wh[ich] remains with a porous tile. So prepared, the rub[ber] forms a translucent mass, free from its usual smell [and] from all danger of decomposition.

The merits and demerits of this mode of prepa[ra]tion must rest entirely with me, but I cannot [be] responsible for any statements made in Trinid[ad], where a copy of my experimental machine [was] recently exhibited without my consent or knowled[ge].

COMMERCIAL EDUCATION IN BELGIU[M].

The necessity of a more complete sytem of techn[ica]l and commercial education has been much experien[ce]d in England of late years, and it is well known t[hat] this question has also greatly occupied the attent[ion] of foreign countries and of our own colonies for so[me] time past. Opinion in England for some t[ime] hesitated in this matter, and the slowness in adopt[ing] a fundamental change in the system of public instr[uc]tion probably resulted from the once generally [ac]cepted idea that a liberal education consisted mai[nly] of classical and mathematical studies. A "go[od] general education" has been held to form the b[est] foundation for whatever a pupil's destiny in life m[ay] ultimately be, and it was difficult to abandon th[ese] traditional opinions at once and to substitute a rad[ica]l change of system for it. A glance at the Belg[ian] mode of instruction, especially as regards commer[cia]l training, may supply some useful information on t[his] subject. The education in the public schools of t[he] country, the "Athénées," was originally, in the ma[in], classical, and it was only of comparatively rec[ent] years that these establishments were separated i[nto] two divisions, or sections, as they are called, that [of] the *Humanités* (classical school) and the *section p[ro]fessionnelle* (commercial and scientific school), or, [as] the latter has been termed, *Les Humanités modern[es]*.

The *Section professionelle* of the "Athenées" to[ok] its place as an integral portion of the public sch[ool] system of Belgium. It was felt, however, that m[ore] was needed to develop the intellectual capacity [of] young men intending to enter mercantile life, a[nd] that the means should be provided for prosecuting [a] higher range of study in that direction to correspo[nd] with the instruction furnished in universities in resp[ect] of the classical and mathematical curriculum. [A] college was founded at Antwerp by Royal Dec[ree] dated October 29th, 1852, under the designation [of] "Institut Supérieur de Commerce" for the purpose [of] supplying this deficiency and the establishment [has] been in full and successful operation ever since. T[he] Antwerp Institute of Commerce is practically spe[ak]ing, a commercial university, although not so in na[me].

Consul General de Courcy Perry states that it lerwent reorganisation in 1897. The diplomas irded by the Institute are two in number, viz., t for the degree of "Licencié en Sciences Com-rciales" and that for the degree of "Licencié du gré supérieur en Sciences commerciales et consu-es." To obtain the superior degree a course of ee years in length must be followed, but the lower loma may be obtained at the end of the second r's study. The superior degree is granted on the lent passing an examination in the following jects. General commercial affairs, commercial and eral geography, political economy and statistics, the eral history of commerce and industry, the general iciples of commercial and maritime law, inter-ional law as far as it relates to commercial affairs, toms regulations in Belgum and other countries, imercial products, shipping and maritime construc-i, languages, French, Dutch, German, English Spanish, or Italian. The syllabus of subjects for third year's examination (for the diploma of icencié du degré supérieur en sciences commerciales consulaires" is the same as the above with the ition of three subjects, viz.:—Constitutional law, isport, and Consular regulations. The third year's iculum was introduced in 1897, mainly with the ect of providing a complete course of study for didates for the Consular service, the two years' rse being deemed sufficient for students destined ordinary commercial pursuits. The course of tical commercial instruction given at the Antwerp itute is one of the most important features of the iblishment. A knowledge of business is inculcated means of what is known as the "Commercial ce." The students attending this course are plied with commercial data from the Antwerp hange, and from all parts of the world, and under supervision of their professors, carry on imaginary rations of all kinds. In this manner a knowledge usiness principles and methods is gained, and at completion of the course an attentive student ild have attained a fair, all-round acquaintance i the ordinary transactions carried on in a cantile house. Such objects as importation, ex-ation, shipping, commission, insurance, bank- &c., occupy a foremost place, and endeavours made to lead the students to bring to bear practical cases the principles and theories they learned in the various special courses of the itute The instruction in science is limited to branches thereof as may prove of use in chemical mercantile pursuits, and the technical and scientific ses at the Institute are greatly facilitated by an llent museum where raw and manufactured ucts, minerals, &c., are carefully classified rding to their commercial or industrial importance. h the object of giving the students a practical ht into the working of modern industrial establish-ts, periodical visits are made to large manu-ries, engineering works, &c. When making visits the students are accompanied by a professor who explains the nature of the machinery and appliances in use, and gives, both in the factory or workshop, and subsequently in the lecture hall, a general review of the particular industry under consideration. The minimum age at which it is considered desirable that a student should enter the establishment is seventeen.

Mr. W. Layton, one of the professors of the Institute, gave some details of the entrance examinations, &c., in a paper read before the Society of Arts, in which he said:—"The students are divided into two classes, viz., 'regular' and 'free.' The former attend all the lectures with a view to obtain the diploma or degree at the end of the second or third year's course. The 'free' student is one who follows only the course of lectures which he considers of paramount importance to him in his commercial career. A 'regular' student must pass an entrance examination in which he must show a competent knowledge of at least two foreign languages, of book-keeping by single and double entry, of geography, arithmetic and algebra, commercial law, and the elements of political economy."

The cost of education at the Antwerp Institut de Commerce is very moderate, as the establishment is maintained partly by the Belgian Government and partly by the Antwerp municipality. The fees paid by the students only amount to £8 for the first year and £10 for the second and third years. These fees are applied to the purpose of supplementing the fixed salaries of the professors. In connection with the Antwerp Institut de Commerce, several travelling scholarships are awarded every year to Belgian students who pass their examination with distinction. These scholarships carry with them a grant of £200 a year for three years, and the holder is expected to go abroad and send home at intervals reports on commercial and economic subjects connected with the country he may have elected to visit. The Antwerp Institut de Commerce is not the only educational establishment in Belgium where advanced commercial studies are made the object of a special curriculum. By a Royal decree, issued in 1896, the faculty was given to the State Universities of Liege and Ghent to confer the degree of 'Licencié du degré superieur en sciences commerciales et consulaires.' The superior commercial degree is conferred at the Universities, and at the Antwerp Institute under somewhat different conditions. In the first place, the certificate of middle class education required as a preliminary qualification on entering the University courses, involves the students having passed through a six years' curriculum at a middle-class school, and thus having received a fairly comprehensive general education, whilst the licentiates of the Institute may obtain their degrees after having gone through a programme embracing only special subjects. The same remark holds good with regard to the other certificates which are accepted as preliminary qualifications for the University commercial courses. They

are evidence of a more complete general education than is demanded by the Antwerp Institute. The University commercial courses are said, by practical authorities in Belgium, to be less suitable for the education of young men destined for ordinary commercial life than for those who intend to enter the Consular service, to practise as commercial lawyers, or to enter on any of those careers in which the principles of commercial law and mercantile customs are a necessary part of a man's intellectual equipment.

THE SALMON FISHERIES OF BRITISH COLUMBIA.

The British Columbia coast of the Pacific Ocean, extending from the 49th parallel to Alaska, is extensive and deeply indented. Vancouver Island and Queen Charlotte Islands, standing out seaward, are separated from the mainland by numerous channels and thousands of islands grouped in minor archipelagos. Stretching inland are many long inlets, the whole configuration being irregular, but exceedingly picturesque and rich in food fishes. To take the fishes first in the order of their importance, there is the salmon, of which there are several varities, enumerated as follows:—Quinnat, chinook or tyee salmon, silver salmon or cohoe, sockeyes or blue-black salmon, dog salmon, humpback, cut-throat trout, steelhead, and Dolly Varden trout, all of which, according to a recent report of the British Columbia Bureau of Statistics, are abundant. The quinnat, the first salmon to appear, is the largest, varying from ten to seventy-five pounds in weight. It is the most important of the salmonidæ family, and for table purposes is the most highly prized. For canning purposes the sockeye is preferred, being more uniform in size and colour, running in immense shoals, which the spring salmon does not, and being higher in colour. On the Columbia River, the former is the most generally used for canning. In British Columbia, the bulk of the fish used for canning is the sockeye, and it is during its run, usually in prodigious numbers at the height, that the pack is made up. As many as 2,000 boats are seen at the mouth of the Fraser at one time, and in big runs they will average from 100 to 500 fish each in a night. It is scarcely possible to estimate the number of these fish that go up the river. The cohoes are a less prized variety, but running later are utilised very often to make a pack, if the run of sockeyes should not be sufficient. When caught in salt water the cohoe is infinitely superior to the sockeye as a table fish, though not so rich in flavour as the tyee salmon. The spring salmon is plentiful on the coast from November to April, the sockeyes make their appearance in July, and run in July and August, and the cohoes in September. The dog salmon and humpback are not commercial varieties, and are never used except by the Indians. The run of salmon first begins in the northern waters, the fish entering the various inlets and rivers a little later in the seas[on] until the Fraser is reached. Canneries are situat[ed] on the Naas and Skeena Rivers, Gardner's Can[al], Rivers' and Knight's Inlet, Alert Bay, and ot[her] points on the coast, but the principal business is carr[ied] on in the Fraser, where some 42 canneries are [in] operation, there being 62 in all, with others in cou[rse] of construction. The industry began in 1876 wit[h a] pack of about 10,000 cases (48 lbs. to a case). T[his] has steadily increased, until, in 1897, it is estimated t[hat] it reached over 1,000,000 cases, valued at £800,0[00]. The principal market for the output is in Engla[nd], though it finds its way to many other markets of t[he] world. The commercial varieties of the salmon a[s a] rule do not rise to the fly, and therefore are not fis[hed] for sport except that at certain times of the year th[ey] are trolled for in the bay, near the cities of the coa[st]. The trout, which abound in nearly all the rivers a[nd] inland lakes of British Columbia, and the salt wa[ter] as well, though differing locally as to size, colour, a[nd] flavour, are said to be identical in species. Th[ey] make up to the sportsman for the obstinacy of t[he] salmon, and attain in places to a size of thirty a[nd] forty pounds. They are not to be mistaken, ho[w]ever, for the "speckled trout," the charr, of wh[ich] there are two varieties, but much less frequent a[nd] more limited in their habitat.

General Notes.

Sofia Commercial Museum.—A Commerc[ial] and Industrial Museum has lately been opened [at] Sofia by the Ministry of Commerce and Agricult[ure], and a catalogue of the exhibits has been published.

Food Exhibition at Bordeaux.—Informati[on] has been received from the Foreign Office, throu[gh] the Science and Art Department, that an Exhibit[ion] of Food and Sanitation will be held at Borde[aux] for three months, commencing on the 20th i[nst.] The classification consists of nine groups. Fore[ign] exhibits will be received up to the 28th inst. T[he] address of the director is M. A. Balasse, 8, Rue [du] Palais Gallien, Bordeaux.

Sisal in Mexico.—The production of sisal g[rass] or ixtle has largely increased in Mexico, and wh[ile] the exports in 1894-95 were 4,342,621 kilogra[ms], valued at £72,820, these in 1896-97 were estima[ted] at 9,635,000 kilograms, valued at £179,200 sil[ver]. The traffic is monopolised by a few commercial hou[ses] chiefly settled in San Luis Potosi and Cerritos. Th[ese] houses send their products to the markets at N[ew] York, Hamburg, Havre, and small quantities are s[ent] to Antwerp.

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ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted or a juvenile audience will be given on Vednesday evenings, January 4 and 11, 1899, t 7 o'clock, by Professor F. Jeffrey Bell, I.A. (of the Department of Zoology, British Iuseum). The first lecture will be on "Hands nd Feet," and the second lecture on "Some Vays in which Animals Breathe."

A sufficient number of tickets to fill the room ave been issued to members, but a few tickets an still be supplied to such members as have ot received any, if application is made at nce.

LIST OF MEMBERS.

The new edition of the List of Members of ie Society is now ready, and can be obtained y Members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to nd their volumes of the *Journal*, cloth overs will be supplied post free for 1s. 6d. ach, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

ACETYLENE.

By Vivian B. Lewes,

'rofessor of Chemistry, Royal Naval College, Greenwich.

Lecture II.—Delivered November 28, 1898.

In my last lecture I pointed out that Edmund avy first made acetylene from a compound oduced during the manufacture of potassium om potassic tartrate and charcoal, which nder certain circumstances yielded a black compound decomposed by water with considerable violence and the evolution of acetylene.

This compound was afterwards fully investigated by Berzelius, who showed it to be carbide of potassium. He also made the corresponding sodium compound and showed that it evolved the same gas, whilst in 1862 Woehler first made carbide of calcium, and found that water decomposed it into lime and acetylene.

During the past few years a wordy war has raged as to whether the discovery of the processes by which calcic carbide is now produced is due to the French chemist Moissan, or to the Canadian experimentalist Willson, and many still seem to imagine that it is the discovery of calcic carbide and acetylene that is in question. In point of fact our knowledge has advanced but little, save in details, since the labours of Davy, Woehler, and Berthelot clearly defined the preparation and properties of this beautiful illuminant, and the only question in dispute is as to who translated the manufacture of carbide and the preparation of acetylene from the ranks of a laboratory experiment of mere scientific interest to a commercial success.

Carron, in 1860, obtained an alloy of calcium and zinc by heating lime and zinc to a high temperature, and Woehler made his calcic carbide by heating to a very high temperature a mixture of lime, zinc and carbon, which first formed the calcium zinc alloy and then the carbide, the zinc being volatilised, and the compound which he obtained was impure and very unlike the beautiful crystalline substance obtained at the present time.

It was Sir Humphry Davy who first demonstrated the heat and light of the electric arc, and it was late in the seventies that Sir William Siemens inaugurated an entirely new era in experimental and metallurgical work by patenting his electrical furnace, in which the electrical energy could be converted into heat, thus yielding a temperature which had never been before available, and which has been estimated by Violle as approximating to 3,500° C. As gradually the utility of the electrical furnace came to be recognised, other patents began to be taken out, Bradley patenting a furnace in 1883, whilst Cowles took out his patents in 1885, and in 1886 patented a lining of lime and carbon for the furnace, as being more refractory. Although these furnaces were used for making aluminium, large quantities of carbide of calcium were accidentally made by the action of the heat on the furnace lining, and during 1886 and 1887 the lads employed

in the works used often to amuse themselves in the dinner hour by putting water on the old crucible linings and igniting the gas which was set free. Even before this date it was recognised and published that in the Cowles electric furnace the oxides, not only of the alkaline metals, but of calcium, magnesium, aluminium, silicon, and boron could be reduced in the presence of carbon and could be made to form alloys with other metals present, whilst with aluminium and other metals the crystalline compound made with carbon could be obtained, and further that silicon and the compound of silicon with carbon could be produced.

It is clear, therefore, that as early as 1886 calcic carbide was made in the electric furnace, but its formation was merely accidental, and no commercial importance was attached to it.

Soon after this date Willson conceived the idea of reducing aluminium in the presence of copper to make aluminium bronze, and employed practically the same method as that used by Cowles, but as his attempts to make the bronze were not successful, and as he was unable to make aluminium owing to the Cowles patents, he attempted to reduce magnesium and calcium to the metallic state. It was in the spring of 1892 that he attempted to reduce lime by carbon, and he found that he obtained by this means a fused bath, the boiling of which caused the short circuiting of the electric arc, and in order to prevent this spitting of the liquid and the unequal loading of the dynamo which interfered seriously with the working of the machinery and water turbines, he added to it carbon which prevented the splashing of the liquid against the sides of the electrode, the only portion of the surface exposed being in the immediate path of the arc.

It was in the May of 1892 that carbide was obtained by Willson in quantity, and samples were sent by him to various scientific friends in America, and it was on September 16, 1892, that he privately sent specimens of his carbide to Lord Kelvin with a letter. A copy of this letter I have seen in Willson's letter book, and it amply proves that he was perfectly aware of the importance of this product. It was acknowledged by Lord Kelvin in a letter, dated October 3, 1892.

About this time M. Moissan was conducting his classical researches on chemical actions at high temperatures, using for his experimental work an electrical furnace identical with the one patented by Siemens in 1879. Whilst experimenting with calcium he found that the vapours of the metal acted upon the carbon electrodes, forming calcic carbide in small quantities, a fact which he incidentally mentioned in a paper read before the Academie des Sciences on December 12, 1892. This discovery contained no more of the germs of a commercially possible manufacture than had the discovery of calcic carbide by Woehler, or the attempts of Borchers to make calcic carbide in his experimental furnace, which had extended from 1885 to 1891. Borchers had succeeded in making this body although he had no idea of the importance of his investigations, which certainly were not of a practical kind.

The history of the manufacture of the carbides was also added to in this year by M. L. Maquenne, who showed on October 17, 1892, that barium carbide could be made by heating barium carbonate with magnesium in the state of powder and charcoal; whilst Mr. Travers, on February 6, 1893, published his method of making carbide of calcium by heating a mixture of chloride of calcium with metallic sodium and carbon.

It is quite clear that up to the end of 189[illegible] it was Willson, and Willson only, who had made calcic carbide on anything like a large scale, and nothing would ever have been heard of this material on a commercial scale, had it not been that he, in attempting to get capital invested in his process, came across several men of sound practical knowledge, whose business instincts led them to grasp the possibilities of carbide and acetylene, and no sooner had these commercial possibilities been noised abroad than others began to try and make capital from them. In France, in 189[illegible] Bullier took out a patent for the preparation of the carbides of the alkaline earths, based on Moissan's researches. M. Moissan himself has never claimed priority in the manufacture of commercial carbide, and, indeed, whilst lecturing before the New York section of the Society of Chemical Industry, on October 26, 1896, he distinctly stated that the credit of the first production of calcic carbide on a commercial scale, and the industrial utilisation of acetylene belonged to the Americans, and it seems to me that when this is shown on Moissan's own evidence, further comment is needless.

Willson continued his experiments on the manufacture of carbide on a commercial scale through 1892 and 1893, and, having formed a company, of which Major Morehead was the president, the manufacture was continued at the works at Spray, in North Carolina, in which a dynamo, worked by water-power, an[illegible]

enerating a current of 2,000 amperes and volts, was employed.

By this time the manufacture of carbide as well launched, and the first English ant for its production was erected at Leeds, hilst later on a large installation driven by ater-power was erected at Foyers and has en working ever since. This is the source om which nearly all the self-titled manufacturers of calcic carbide in this country tain their supplies.

On the Continent at the present moment rge numbers of works have been erected, hilst others are in progress; the rapid mand for carbide which has arisen owing the introduction of acetylene for railway rriage lighting and the illumination of small wns has outstripped the supply, and from me to time carbide famines are threatened, hilst the price of the material fluctuates nsiderably. Practically the same condion exists in America, although the output nounts to between 10,000 and 12,000 tons per inum, so that although the manufacturers generators in this country are fond of umbling at their orders not being filled as pidly as they wish, they may console themlves with the fact that they are far better than their rivals in most parts of the world. ven in Germany, which claims pre-eminence the various branches of chemical manucture, they obtain up to the present by r the largest portion of the supply of carde from Switzerland, where the works at euhausen turn the carbide out at a lower ice than can be charged by the Bitterfeld orks in Prussian Saxony, which had used am instead of water-power. The latter mpany, however, has now removed its ant to Neuhausen, where it will re-open th water-power for the generators, and is ecting works capable of turning out a very ge yield.

The reports of Mr. Frank H. Mason, the nerican Consul-General at Frankfort, which nstitute perhaps the most valuable contribun to our knowledge of Continental industries, ing to the writer's great practical experience d the accuracy of his information, point out at the whole of the carbide industry, so far as ntral Europe is concerned, is now in a transin stage. The conditions of supply and price e likely to be greatly modified by the enorms increase of production which is now being anged for, as not only have the factories in rmany, Austria, and Switzerland, at work d in course of construction, arranged for the utilisation of 35,000 horse-power to be devoted to this purpose, but another important accession will come through the operations of a big combination, headed by the Schukert Electrical Manufacturing Company of Nuremberg. This company expects to have in operation during the course of next year works in various parts of Europe where water-power can be obtained cheaply, to the amount of about 18,000 horse-power, capable of producing some 20,000 tons of carbide per annum. There are also ten factories at work in France, whilst four others are in course of construction.

In the manufacture of calcic carbide in the electric furnace, lime and hard metallurgical coke, of the highest possible degree of purity, are employed. A good working mixture of these materials may be taken as being 100 parts by weight of lime with 68 parts by weight of carbonaceous material, and about 1·8 lbs. of this is used up for each pound of carbide produced. It must not be forgotten, in computing the cost of carbide, that lime of sufficient purity for the purpose is not only costly, but difficult to obtain in large quantities.

It is found that as the ingot of calcic carbide is formed in the furnace, although the ingot itself consists of pure crystallin calcic carbide, it is nearly always surrounded by a crust in which the carbide contains a certain proportion of imperfectly converted constituents, which, therefore, give a lower yield of acetylene than the carbide itself, and in breaking up and sending out the carbide for commercial work, packed in air-tight drums, the worst of the crust is, as far as possible, picked out and rejected. It is, perhaps, misleading to state the amount made per E.H.P., as a certain amount of loss is of necessity entailed during the breaking down and packing, for instance, in practical working I have found that whilst the furnace return was 0·504 lbs. per kilowatt hour, this amount has been brought down to 0·406 lbs. per kilowatt hour when the material has been broken up, sorted, and packed in air-tight drums.

It will be sufficient for practical purposes to state that the cost of material, labour, and wear and tear of plant, independent of the power used in the electric furnace but inclusive of packing, for making a ton of packed carbide will amount to from £3 to £4, according to locality, and this, of course, entirely governs the cost of the materials used, whilst the cost of the electrical horse-power necessary for the conversion of the material will entirely depend on whether it is obtained from steam, gas-

engines, or water-power, the latter where obtainable being the cheapest, and in this country costing nearly £4 per E.H.P. per year.

The two principal processes utilised in making calcic carbide by electrical power are the ingot process and the tapping process.

In the ingot process, the coke and lime are finely ground, and carefully mixed in the right proportions to suit the chemical actions involved. The arc is struck in a crucible, and the powdered mixture allowed to flow in, and partially fill the crucible. An ingot gradually builds up from the bottom of the crucible, the carbon electrode being raised from time to time automatically or by hand to suit the diminution of resistance due to the shortening of the arc by the rising ingot. The crucible is of metal, and considerably larger than the ingot, the latter being surrounded by a mass of unreduced material which protects the crucible from the intense heat. When the ingot has been made and the crucible is full, the latter is withdrawn, and another substituted. The process is not continuous, but a change of crucibles only takes two or three minutes under the best conditions, and only occurs once in every ten or fifteen hours. The essence of this process is that the coke and lime are only heated to the point of combination, and are not "boiled" after being formed.

In the tapping process a fixed crucible is used lined with carbon. The electrode is nearly as big as the crucible, and a much higher current density is used. Fine grinding is unnecessary, as combination probably only takes place after fusion of the raw materials which mix more or less as liquids. The carbide is heated to complete liquefaction, and tapped at short intervals. There is no unreduced material, and the process is considerably simplified, whilst less expensive plant is required; but on the other hand, the output in carbide per E.H.P. per day is considerably less than in the ingot process, and it is only more economical where power is comparatively cheap.

Many attempts have been made to economise the amount of current necessary in making the carbide by heating a mixture of lime and carbonaceous material before exposing it to the action of the arc, but it has never been clearly demonstrated that any economy has been gained by doing this.

When the manufacture of calcic carbide was in its infancy, the idea of pre-heating the constituents to save the current was a favourite one with inventors, and a large number of patents were taken out for electric furnaces working on this principle, but with extended practice the fallacy of this economy has become apparent.

The best carbide is made when a finely powdered and intimate mixture of pure lime and coke of very low ash is presented to the action of the arc for just sufficient time to fuse it and convert it into carbide; if, however, attempts are made to pre-heat this mixture by exterior heating, some of the carbon is burnt away and the proportion of carbon to lime altered, whilst if interior heating be attempted, the rush of hot gases carries away the lighter particles and destroy the homogeneous nature of the mixture in that way as well as by burning off carbon. If attempts be then made to overcome these evils by using a coarsely ground mixture of the ingredients a bad carbide is produced owing to the interaction between the carbon and the lime never being properly completed. In attempting to overcome this last trouble the material is often kept too long in the arc, thereby lowering the quality of the carbide still further by overheating.

M. Nicolai has shown that overheating leads to dissociation of some of the carbide, and the result of this is well shown by re-melting a sample of carbide of known composition, after which it develops about 12 per cent. less gas than before, whilst a second re-melting more than doubles the loss. A second grave disadvantage of overheating also is that metallic calcium is produced, which, during the decomposition of the carbide by water, gives rise to hydrogen.

In one class of furnace the raw coke and lime are heated before entering the furnace crucible by being placed in a metal bin subjected to the action of the hot furnace gases, and sometimes heated by a fire underneath.

Pictet places a mixture of comparatively large pieces of lime and coke, with a considerable excess of the latter, in a refractory crucible which has a hole at the bottom, below which a horizontal arc furnace is situated. A row of tuyeres round the upper part of the crucible supplies a hot-air blast which consumes some of the coke that has been previously ignited, and thereby heats the descending charge. A second row of tuyeres lower down in the crucible supplies water gas and hot air simultaneously, and heats the mixture to a still higher temperature. The mixture then passes out between the carbon poles, and

the carbide is said to be made. Here, again, it is very doubtful whether the economy claimed for this process is borne out in practice, as the gain from the prior heating of the material, if any, is more than counterbalanced by the difficulty of reducing the large lumps, whilst the expense of the water gas and air blast would be no small item, and the quality of the carbide in all probability would not be of the best.

There is a rotating furnace which is used in one large works in the United States, and modifications of this are, I believe, being tested by Mr. Willson, and have been fitted up at Niagara.

A rotating drum of cast-iron is fitted round its periphery with a number of removable iron plates, thus forming an annular space on the outside. The carbon electrodes are placed in a hopper made of refractory material at one side of the drum, the electrodes being parallel to two opposite sides of the hopper, and meeting with the formation of an arc just over the annular space in the drum. Only one-half or two-thirds of this annular space is closed at one time, the closed part extending from just below the hopper to the other side downwards. A mixture of powered coke and lime is fed into the hopper, some falling between the electrodes, which are then drawn apart as carbide is formed until a block of carbide four or five inches thick is built up between the electrodes, whilst an arc plays on both sides of the block between them. The electrodes are not clamped down, and as the ingot tends to short-circuit the arcs, the drum is rotated a little by means of worm-gearing, thereby drawing a little of the ingot and mixture into the annular space and introducing more raw material to the arc.

This process goes on continuously until the carbon poles are exhausted; the carbide forms round the drum and is broken off in pieces on the other side by removing the periphery plates as they come round.

I have had the good fortune to be able to secure photographs of some of the most interesting machinery connected with the carbide manufacture, and you will see that the plant used at nearly all the large factories may be looked upon as developments of Willson's original plant as used at Spray—the figure of which on the wall I think is of exceptional interest.

During the past year the air has been full of reports as to various processes for making carbide without the aid of electricity, and it is said that this has been successfully accomplished; but I confess that until I have the evidence of my own senses to go upon, I shall remain sceptical as to the carbide being produced more economically by such means than by electricity, even if produced at all on a large scale.

In 1894 and 1895 I made many experiments in this direction, built up small experimental plant, and used every method for generating high temperatures that was available, and succeeded in fusing practically everything save the mixture of lime and carbon. It was an easy matter to run down the lining of the furnace, indeed, to melt up the whole furnace itself, but the direct combination of the carbon with the lime was not to be obtained in that way. It then seemed probable that the result might be obtained by highly heating lime in the presence of decomposing hydrocarbons, so that the nascent carbon might combine with the lime at the moment of its liberation; but this was tried in many different ways without any very encouraging results, although it is possible by decomposing such organic compounds as calcic tartrate by heat, and raising the temperature of the mass to get traces produced; the price, however, under these conditions of the organic compounds, would be prohibitive.

Another point which always seemed to me to be against the direct formation of calcic carbide by heat is that the temperature needed for its formation is 2,700° C., and if you take calcic carbide and attempt to fuse it at any obtainable temperature short of the electric arc, you fail to do so, whilst if the oxy-hydrogen blowpipe be used for this purpose, not only do you fail to fuse the carbide, but you decompose that which you already have, and the lump which you have left behind consists mainly of carbon, carbonate of lime, and lime. It is possible, however, that by using carbon burning in oxygen a sufficient temperature could be reached to fuse the mixture of lime and carbon with the formation of carbide, but the temperature which would do this would prove fatal to the furnace itself. There is not the slightest doubt that the next year will see very many experiments made with gaseous mixtures, rich in oxygen, made at a remarkably cheap rate by methods such as the Linde process for liquefying air and allowing the nitrogen to boil off, and some of these may be successful in overcoming the existing difficulty.

It is reported that Dr. Borchers has succeeded in making carbide by some method akin to this, but there are many considerations

which lead to the belief that even if this feat has been accomplished, its practical value will be but little. Given water gas, regenerative settings, and cheap oxygen, an enormously high temperature can be attained, but the material of which to build a crucible or furnace that will stand it has yet to be discovered.

In using the electric furnace the intense heat of the electric arc is generated in the centre of the mass to be fused by it and so the wear and tear to the furnace is avoided, but this would be impossible even if the requisite temperature could be reached by a combustion process, and the result would be that the electrical heating would probably be less expensive than the other.

It is perfectly well known that if a temperature commercially practicable is to be used, some metal with a strong affinity for oxygen must be employed to reduce the lime to calcium before combination with the carbon will take place. Such metals as will do this, potassium, sodium, and magnesium, or even zinc, are, however, costly, and if a process were devised in which the vapours of such metals were liberated by reduction from their salts, and were made to interact with carbon and lime at a high temperature, it could only be made commercially possible either by a large demand being created for the bye products, or by its being capable of being cheaply worked up and used over again. In either case the probabilities are that the cost would exceed that of making carbide by electricity generated by water-power.

Another point of a purely unscientific character is that during the past few months very large amounts of capital have been subscribed for the erection of factories for making carbide by water-power on the Continent, and practically little or none can be traced for processes for making carbide without electricity, which shows no great amount of confidence in the many schemes suggested.

There is a company at Leipsig, having works at Cassel, who are supposed to make calcic carbide without electricity, by smelting the constituents by acetylene blow-pipes, working under considerable pressure, but it does not appear possible that this could be made to compete economically with the ordinary electrical method.

One of the schemes for the manufacture of carbide is for producing it from blast furnace slag, which contains a certain amount of lime, together with all the impurities derived from the fuel, ore, and limestone used in the furnace. According to the inventor, this mixture is to be run into Bessemer converters, impregnated with coke powder blown into it through the converter trunnion, and then poured out between a series of carbon electrodes, between which a powerful current is flowing, and in twenty minutes this converts the slag into a material named by the inventor "carbolite," and which is supposed, on contact with water, to yield 5 cubic feet of gas per pound. Such a substance might contain 40 per cent. of calcic carbide, but the impurities would be so pronounced that it would be practically useless for the generation of acetylene for indoor lighting.

Carbide of calcium, as formed in the electric furnace, is a beautiful crystalline semi-metallic-looking solid, having a density of 2·22, and showing a fracture which is often shot with iridescent colours. It can be kept unaltered in dry air, but the smallest trace of moisture in the atmosphere leads to the evolution of minute quantities of acetylene, and gives it a distinctive odour. It is infusible at temperatures up to 2,000° C., but can be fused in the electric arc. When heated to a temperature of 245° C. in a stream of chlorine gas it becomes incandescent, forming calcic chloride and liberating carbon, and can also be made to burn in oxygen at a dull red heat, leaving behind a residue of calcic carbonate. Under the same conditions it becomes incandescent in the vapour of sulphur, yielding calcic sulphide and carbon disulphide, whilst the vapour of phosphorus will also unite with it at a red heat. It is a compound of—

	Per cent.
Calcium	62·5
Carbon	37·5
	100·0

Acted upon by water calcic carbide is at once decomposed, yielding acetylene and calcic hydrate. Pure crystalline calcic carbide yields from 5·5 to 5·8 cubic feet of acetylene per pound at ordinary temperatures, but the carbide as sold commercially is a mixture of the pure crystalline material with the crust which in the electric furnace surrounds the ingot, and which of course yields less gas. The two being blended together yield an average of 5 cubic feet of gas per pound of carbide under proper conditions of generation; but as we shall see later on, the volume of gas to be obtained from the carbide depends very largely upon the form of apparatus used, and whilst some will give the full 5 cubic feet

er apparatus will only yield with the same bide $3\frac{3}{4}$ feet.

The purity of the carbide entirely depends on the purity of the materials used in its nufacture, and before this fact had been y grasped by the manufacturers of carbide, l only the purest material obtainable em-yed, the carbide contained notable quantities compounds which, during its decomposition water, yielded a somewhat high proportion mpurities in the acetylene generated from Although at the present time a mar-llous improvement has taken place all round the quality of the carbide produced, the etylene nearly always contains minute ces of hydrogen, ammonia, sulphuretted drogen, phosphuretted hydrogen, siliciur-ed hydrogen, nitrogen, and oxygen, and netimes minute traces of carbon monoxide d dioxide.

The formation of hydrogen is caused by all traces of metallic calcium occasionally nd free in the carbide, and cases have been own where this was present in such antities that the evolved gas contained arly 20 per cent. of hydrogen. This takes ice when, in the manufacture of the carbide, material is kept too long in contact with arc, as this over heating causes the dis-ciation of some of the calcic carbide, and the ution of metallic calcium in the remainder.

The presence of free hydrogen is nearly vays accompanied by siliciuretted hydrogen, ich is formed by the combination of the scent hydrogen with silicon in the carbide. has usually been stated that this siliciuretted drogen has been formed by the decomposi-n of silicides present in the carbide, but in ite of a long series of experiments which I ve made, I have never yet been able to m a metallic silicide which will decompose th water with the evolution of this gas, and silicides which analyses prove to be present the carbide are certainly not decomposed in s way.

The ammonia found in the acetylene is due the presence of magnesium nitride in the rbide, and this is formed by the metallic gnesium in the molten condition in the got taking up nitrogen from the air, and ien this comes to be decomposed by water nmonia is produced by the action of steam of nascent hydrogen on the nitride, the antity formed, however, depending very gely upon the temperature at which the rbide is decomposed.

The formation of nitrides by actions of this kind and their easy conversion into ammonia will probably, at some no very distant date, prove to be a useful method of fixing the nitrogen of the atmosphere and rendering it available for manurial purposes, although it could never compete in price with the ammonia formed in the destructive distillation of coal for coal gas.

Sulphuretted hydrogen, which is invariably present in commercial acetylene, is formed by the decomposition of aluminium sulphide, and it has been shown by Murlot that aluminium sulphide, zinc sulphide, and cadmium sulphide are the only sulphur compounds which can resist the heat of the electric furnace without decomposition or volatilisation, and of these aluminium sulphide is the only one which is decomposed by water with the evolution of sulphuretted hydrogen.

In the early samples of carbide this compound used to be present in considerable quantity, but now it has been reduced to so small a limit that one rarely finds more than one-tenth per cent. of sulphuretted hydrogen in the acetylene generated from commercial carbide.

Phosphuretted hydrogen, one of the most important impurities, which has been blamed for the haze formed by the combustion of acetylene under certain conditions, is produced by the action of water upon traces of calcic phosphide found in carbide. Although at first it was no uncommon thing to find half a per cent. of phosphuretted hydrogen present in the acetylene, this has now been so reduced by the use of pure materials that the average quantity is rarely above one fifteen hundreth of a per cent., and it is often not one-fifth of that.

I have made many experiments on the effect of the impurities in calcic carbide upon the safety of the material, and have come to the conclusion that such impurities as are now found in the commercial carbide may be looked upon as practically innocuous. With proper care and supervision in the selection of the materials for making the carbide, all trouble on that score may be disregarded, as spontaneous ignition due to the liberation of phosphuretted hydrogen would be the chief risk dependent upon the use of the impure material.

In the earlier days of carbide manufacture several cases of spontaneous ignition of the gas occurred, and although the analyses of many different brands of carbide from all countries of the world show that in the carbide itself there is not sufficient impurity to bring

about this result, it seemed possible that the concentration of the phosphorus compounds might take place in the outer crust formed around the ingot during manufacture, and experiments were made to see if this were so.

By the courtesy of the Acetylene Illuminating Company a portion of an ingot with its crust intact was obtained, the crystalline material of the ingot containing 96·7 per cent. of true carbide, whilst the crust, although varying very much in composition according to its distance from the ingot, contained an average of 51·9 per cent. of carbide. A second couple of ingot and crust gave even better results, the ingot containing 90 per cent. of carbide, and the crust 77 per cent.

Analyses were made of the acetylene from these samples, but the results showed no indication of the poorer material being richer in phosphorus compounds than the ingot itself.

On breaking up some ingots of calcic carbide, metallic nodules manifestly differing from the pure carbide are observed, and are far more abundant in specimens of foreign manufacture than in English made carbide. These nodules are generally found in a spherical or oval shape, and have evidently separated from the molten mass on the crystallising of the true carbide.

From this it seemed highly probable that a concentration of the impurities might take place, and that the presence of these nodules might be an active source of danger.

In order to verify this point calcic carbide was obtained in bulk, and both English and foreign makes were represented. This carbide was then carefully broken up, and the nodules and anything which appeared to differ from the true carbide were collected. The nodules differed somewhat in appearance, two distinct varieties being clearly noticeable :—

(*a*.) Grey nodules, not attracted by the magnet, not oxidised when exposed to air or heated as a solid lump in the blowpipe flame. Specific gravity, 3·5 to 5·8. In a fine powder some had a very faint garlic-like odour, gained 5 per cent. when heated for half-an-hour, and attacked platinum when heated on it for some time. These nodules gave no gas when acted upon by water.

(*b*.) Steel-like nodules, which were strongly magnetic, and became coated with iron rust when exposed to moisture and air for some time, and which gave no gas when acted on by water. Specific gravity, 6·3 to 6·8.

Analysis showed that the foreign matter present in the carbide consisted of carborundum or silicide of carbon, metallic silicid[e], iron, occasionally metallic calcium, m[ag]nesium, aluminium, and traces of nitrid[es], phosphorus, and sulphur compounds. On[e of] the nodules on analysis yielded :—

	Per cent.
Silicon	30·76
Iron	58·06
Calcium	2·65
Aluminium	3·01
Magnesium	0·64
Carbon, &c.	4·89
	100·00

None of these substances gave spon[ta]neously inflammable gases when acted u[pon] by water, but in a few instances a nodule [was] found which evidently contained magnes[ium] silicide, and which when powdered and ac[ted] upon by hydrochloric acid, gave a few bubl[es] of spontaneously inflammable gas.

M. C. Gerard, chief of the Munic[ipal] Laboratory at the Prefecture of Police, Pa[ris], has also analysed some of these nodules, [with] the following results, and found that t[hese] alloys, pulverised and treated with concentra[ted] acid, gave off siliciuretted hydrogen : –

	I. Per cent.	II. Per cent
Iron	55·027	53·250
Silicon	33·172	31·800
Aluminium	5·579	8·910
Calcium	2·764	4·120
Not determined and loss	3·458	1·920
	100·000	100·000

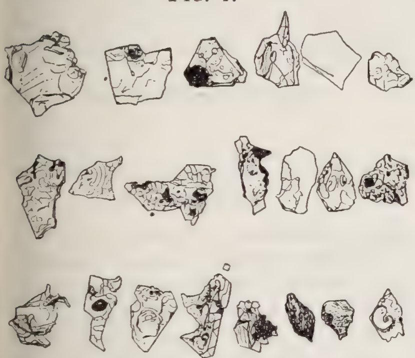
In some cases it was found that the car[bon] deposited by holding a cold surface in [an] acetylene flame contained traces of silica, [and] this seems to support the idea that siliciure[tted] hydrogen may occur in the acetylene, but, [if it] does, the amount is so small as certainl[y to] give no danger of spontaneous ignition.

A sample of gas which appeared to gi[ve a] considerable quantity of silica was b[urnt] under such conditions as to allow of the s[ilica] being collected, and on estimating the qua[ntity] formed it was found to correspond to 0·01 [per] cent. of siliciuretted hydrogen in the orig[inal] gas.

M. Gerard also carried out a numbe[r of] extremely interesting experiments upon [the] products found in the residues left after trea[ting] the calcic carbide with water, and succee[ded] in extracting from them minute diamo[nds]. The residues were, as far as possible, disso[lved] in hydrochloric acid, and the insoluble po[rtion] separated by filtration and washing with wa[ter]

d the metallic portions separated by sieving. ıe finer portions were collected in a filter per, washed and dried, and were then heated th potash in a silver capsule, and the insoluble rtion treated with aqua regia. After re-ating this drastic treatment two or three nes, the residue was put into a separating nnel containing a saturated solution of the ıuble iodide of mercury and potassium, which s a density of 2·9, in which silicide of carbon ll float, whilst graphite sinks. This silicide carbon is then purified by being treated veral times with concentrated hydrofluoric id, and after washing is dried, whilst the aphitic bodies are treated and separated th iodide of methylene, which has a density 3·29. The separation of diamondiferous odies from the silicides of carbon is effected a saturated solution of cadmium bromo-ngstate or iodide of barium and mercury.

FIG. 1.



ILICIDES OF CARBON FROM ENGLISH CARBIDE.

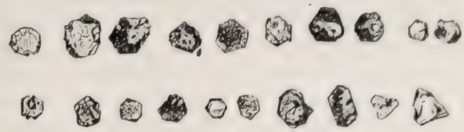
Microscopic slides of these various bye-pro-ucts were sent by M. Gerard to Mr. Worth, the Acetylene Illuminating Company, who om the first has kept in touch with all the ading chemists in Europe, and has supplied ıem with any samples of English carbide that ıey needed, and it is through the courtesy of [r. Worth that I am able to show you these ıe slides prepared from the bodies extracted y M. Gerard.

FIG. 2.

DIAMONDS FROM ENGLISH CARBIDE.

The labour entailed in the separation of ıis diamond-containing powder may be esti-mated, when it is stated that it was necessary to treat no less than between 700 and 900 lbs. of carbide in order to obtain 15·4 grains of this material.

FIG. 3.



VARIOUS SILICIDES OF CARBON.

The evidence upon which M. Gerard bases his assumption, that these minute crystals are in reality diamonds formed at the intense temperature of the arc, is that when they are burnt in oxygen they yield nearly the theoretical volume of carbon dioxide. M. Moissan has failed to find diamonds in the specimens of carbide he has examined, but this is probably due to the quantities worked with, being far smaller than those treated by M. Gerard.

There is no more risk in the storage of calcic carbide than there is in storing any other inert material, provided it is packed dry and warm in hermetically sealed drums so as to render it impossible for it to come in contact with water or moist air.

The real risk is in the removal or redistribution of the material, as after opening a drum it may not be again properly closed, and if the drum be left in this condition in the moist air of an ill-ventilated cellar, it is quite possible for a slow generation of gas to take place, and an explosive mixture to be formed by its accumulation.

All carbide stores should be thoroughly ventilated and above ground, and when this is the case all danger is practically done away with.

For the carriage of carbide it is important that not only should the drums be air-tight, but that they should be of sufficient strength to resist the rough usage incidental to the handling of a heavy product, and where tins are used they should always be protected by an exterior wood case.

Miscellaneous.

PINEAPPLE FIBRE.

The Calcutta periodical, "Capital," as reported in the *Board of Trade Journal*, states that it appears somewhat curious that pineapple fibre was years ago experimented with and condemned by English spinners. In India also, although no difficulty apparently attends the separation of the fibre, it is

turned to very little account. The far-famed weavers of Dacca, when long since an attempt was made to induce them to bring the staple into use, would have none of it. In Burma again, where the plant is so abundant, the fibre seems to be utterly neglected.

On the other hand, there is a considerable amount of information extant which seems to furnish corroborative evidence as to pineapple fibre actually possessing the essential properties required to make it a good substitute for flax. It has even been claimed that in both its wild and cultivated forms the pineapple yields fibres which, when spun, surpass those obtained from the ideal flax in strength, fineness, and lustre.

It has been stated that a certain quantity of the fibre prepared at Singapore tested against an equal quantity of flax sustained 350 lbs., while the latter could not bear more than 260 lbs. Another advantage held to be peculiar to pineapple fibre is imperviousness to moisture. Ropes made of it are thus said to withstand constant immersion in water; and for the same reason and its non-liability to rot it is used in India for threading necklaces.

As to the characteristics that render it readily adaptable for textile purposes, it has been observed by one writer on the subject that the mere process of bleaching suffices to destroy the adhesion between the bundles or fibres, and so renders it fit for spinning in the same way as flax. The isolated filaments are described as very fine, of a tolerably regular diameter from end to end, but of different size, of remarkable flexibility, curling and crisping readily under mechanism. It has been confidently asserted that the fibre can be employed as a substitute for silk, and as a material for mixing with wool and cotton, as silk is now so extensively employed. For sewing thread, twist, trimmings, laces, curtains, and the like, its particular qualities seem to render it specially applicable.

From the pineapple of the Philippines a famous cloth is manufactured, much esteemed for its fine hair-like fibres, but this is considered as perhaps belonging to a different species. Reference has also been made to a plantation established years ago at Singapore by a Chinaman, who there prepared pineapple fibre for export to his native country to be used "in the manufacture of linen."

GRAPHITE IN BOHEMIA.

Since the Cumberland and also the Siberian deposits of graphite, or plumbago, have been practically exhausted, the chief supply of this mineral has been derived from Bohemia, in the south of which country, near Schwartzbach and Murgan, deposits of pure graphite are found in the gneiss, accompanied by crystalline limestone. The mines and works at the former place are owned by Count Schwartzenburg, and those at the latter by the peasants; and these two centres yield the purest graphite now available, that of Krummau being far inferior. When th mineral is not sufficiently pure to be sent away a natural graphite, it is ground in mills constantl traversed by a stream of water that takes up th powdered graphite, which is afterwards thrown dow in the form of mud; and when the mud layer ha attained a sufficient thickness, it is subjected to pressure of six atmospheres (88 lbs. per square incl in a filter-press. The resulting cake, containing mo than 20 per cent. of water, being then dried in stove heated to 90 or 100 degrees (mean 203 Fahr for 24 hours. Out of the 9,000 quintals (885 ton of graphite which are turned out yearly on a average in Bohemia, two-thirds are exported; but i is only during the last few years that the productio has been considerable. Out of the twelve graphit mines in Bohemia only the three named above ar actively worked, occupying 728 hands. Althoug the prices of graphite, and especially natural graphit have slightly fallen since, the best quality now obtain only 15·2 florins (28s. 7d.) instead of 20 flori (38s. 4d.) per metric quintal (2 cwt) as formerly, th mean annual cost of production has increased fro 3·22 florins (6s. 0½d.) to 5·12 florins (9s. 7¾d.), owin to the better qualities being more in demand than th inferior.

THE MANUFACTURE OF PERFUMES I FRANCE.

Enormous quantities of flowers are used in th Alpes Maritimes in the manufacture of perfumes. I has been estimated that of roses alone 2,000 tons ar annually treated; orange flowers, 2,500 tons; jessa mine, 200 tons; cassie *(Acacia Farnesiana)*, 15 tons; tuberoses, 150 tons; and violets, 200 ton The average selling price per pound of flowers is, i the case of violets and cassie, 1s. 8d.; tuberose 1s. 3d.; jessamine, 1s.; roses, 3½d.; and orang flowers, 3½d. Of the flowers producing essence the orange flower produces 1 lb. of essence- which is called "neroli"—for each 500 lbs. o flowers. As regards the proportionate yield of th other flowers, it is as follows:—Rose, 12,500 lbs. o flowers, 1 lb. of essence; geranium, 500 lbs. o flowers, 1 lb. of essence; mint, 500 lbs. and 1 lb. o essence; lavender, 500 lbs. of flowers to 1½ lb of essence, and the same proportion for eucalyptu There are two processes used for the purpose o extracting perfume from flowers which do no contain the volatile essence. The first may b described as the cold process, and the second as th hot process. The former is generally used for cass *(Acacia Farnesiana)*, jessamine, jonquils, tuberose violets, and some other flowers. Freshly gathere flowers are spread upon a layer of pure lard quarter of an inch in thickness, spread over a she of glass about two feet square, which is framed wood and forms a kind of tray. These trays—som times about 40 or 50 together—are then piled upon o

ther, the flowers are then changed every 12, 18, or hours, according to circumstances, and the process hus continued until the lard is sufficiently charged h perfume. Jessamine and tuberoses are fre-ntly changed as often as 50 times before the lard considered to be sufficiently impregnated, cassie l violets from 30 to 40 times, and jonquils about times only. The fat thus obtained can be packed air-tight tins and conveyed anywhere. When the process is resorted to for the purpose of obtaining impregnated fat, about 40 lbs. of grease are ced in a copper vessel together with about 10 lbs. flowers; the vessel is then placed over a slow and the contents are well stirred. After allowing compound to boil for 10 minutes the vessel is to cool for some hours; an additional 10 lbs. of wers are then added, and the process is repeated il the fat has absorbed the requisite amount of fume. The hot liquid is then poured through a ve, and the greasy flower paste that remains is jected to hydraulic pressure. It is in these two ys that the "pommades" of trade are produced. om these "pommades" perfumed and alcoholised uids are extracted by means of grain spirit and o by spirits of wine. These are the "extraits" of de, and it is by the judicious blending of the ferent essences and concentrated perfumes, obtained the processes above described, that the numerous nts are produced.

THE USES OF PAPYRISTITE.

According to the United States Consul at Zurich, new artificial stone or moss has recently made its pearance on the builders' technical market called pyristite, on account of the ingredients entering o its composition, principal among which is rified paper pulp, obtained from waste paper. pyristite is an improvement on papyrolith, both ving been invented by M. F. Gehre, a civil gineer, of Zurich. It can be used in various ways, t is specially intended to serve as a solid, im-rmeable, and jointless roof or floor, which when ce laid will present a smooth surface as if made one continuous layer. This new material is stated be a non-conductor of heat, cold, or sound, and, hough as hard as stone, has a soft linoleum-like ling to the foot, and is noiseless. Accumulations dust, vermin, or fungi are impossible, there being grooves or joints. The weight is much less than at of stone or cement. One hundred kilogrammes 20 lbs.) of this preparation in a powdered form, hen mixed for use and spread to a thickness of 10 llimetres (·3940 inch), will cover a surface of square metres (91½ square feet). No machinery necessary to prepare the compound, although, save labour, when great quantities are to be ed, an ordinary press can be utilised to advantage. can be moulded or spread in any form or shape, as is the case with cement, the mixing is done on the spot where it is wanted, and it is transported like cement in barrels or sacks. The drying or hardening process is effected in twenty-four hours after spreading and then if desired it can be polished to a high gloss. The inventor's numerous experiments have given good results, and his persistent efforts seem at last, it is said, to have been crowned with success. Taking the opinion of prominent architects who have experimented with the new material there seems to be no doubt that a valuable building material has been discovered which can be utilised in many ways. It is as hard as marble and is practically indestructible, yet it is elastic and possesses all of the qualities mentioned above. It can be cut, sawn, and bored, given any desirable tint, and made to look like marble or mosaic. For roofing purposes it is also valuable. A light iron framework has been invented by Mr. Gehre, and the material is put on in the form partly of plates and partly of mortar, which when united produce a smooth continuous surface. It is adapted to cold as well as to tropical regions, and its stone-like qualities protect it against mice or other vermin. Trials of this material have been made in Russia and Brazil, and the reports received are said to be very encouraging. The material once laid will never contract or warp, and it is elastic, light, and inexpensive in production. For schoolrooms, public halls, corridors, bath-rooms (both floor and walls), terraces, barns, poultry yards, &c., this material can be used, and as a non-absorbent of moisture, filth, or other unhealthy substances, it is said to be without equal as a building material.

Notes on Books.

THE PRANG STANDARD OF COLOUR. Louis Prang, Boston, Mass., U.S.A.

This is an attempt to provide a complete scale or chart of colours by reference to which any given colour may be matched or identified. The inventor takes the spectrum colours (with the addition of the purples formed by mixing the colours at the ends of the spectrum), and classifies them after the manner of the points of the mariners' compass, thus:—red, red red orange, red orange, orange red orange, orange. For convenience sake, the colours are designated by their initials, R., R.R.O., &c.

To form the colour chart, the twenty-four pure colours thus selected are arranged in a horizontal row, while in vertical rows under each colour, appear patches of that colour diluted with successively increasing additions of white. There are six such patches under each patch of pure colour, so that this first chart or plate consists of 7 × 24, or 168 patches. Each horizontal row is designated by a number, so that each individual patch is designated by a number

combined with initials, as R.O.3, R.R.O.5, &c. The second chart is a repetition of the first, with a certain addition of black — to represent colours which are less luminous, and this is followed by other plates, with successive additions of black, or diminutions of luminosity until in the last, or sixth plate, nearly all the colour has disappeared, and we have almost a monochromatic scale of dark and light.

The idea is carefully worked out, and is not without a theoretical value. Its practical value would depend entirely on the permanence of the printed colours—assuming their correctness in the first instance – and it is obvious that permanence could not be trusted after a very brief period.

Catalogue of the Library of the Patent Office. Vol. I. Authors. London: 1898. 4to.

This volume contains 1,007 pages in double columns, with about 38 entries in each page, some of these being cross references. There is no preface, but as this first volume is described as an alphabet of authors it may be presumed that the second volume will be devoted to an index of subjects. Although this volume is described as an authors' catalogue, it contains entries of anonymous books and periodical publications. Unfortunately, by the adoption of a fanciful (although a constantly-followed) rule of placing the titles of anonymous works under the first word not an article or preposition, many of the books will not be easy to find before the index is ready—as for instance, A B C of Photography under A, and several treatises under *Account, Description*, &c.

Lectures on the National Gallery. By J. P. Richter. London: Longmans. 1898.

This volume, which is fully illustrated, contains the result of the author's researches concerning certain pictures in the National Gallery, which were the subject of his lectures at the Royal Institution in February of the present year. The topics of the lectures are:—1. The Paintings of the Fourteenth Century. 2. The Origin of the Venetian School of Painting—Giovanni Bellini. 3. Sandro Botticelli and his School.

Prof. Wickhoff, of Vienna, in his essay on Guido da Siena, expresses a doubt whether any pictures can now be determined as the works of Cimabue, and Dr. Richter is of opinion that the doubt is fully warranted. The latter believes the altarpiece of the Rucellai Chapel of the Church of Santa Maria Novella, Florence, which is said to be the masterpiece of Cimabue, to be really the work of Duccio, of Siena. The great mosaic of St. John the Baptist, the authenticity of which is attested by contemporary documentary evidence, still exists in the Cathedral of Pisa. Cimabue only provided the cartoon, and did not execute the mosaic. This has been so frequently repaired, that as Dr. Richter affirms, it would never in its present condition be ascribed to *any* great master.

Further, Dr. Richter believes that not a single picture in the National Gallery comes from the hand of Giotto himself, but he adds that in this the National Gallery is not at a disadvantage when compared with the picture galleries of the Continent, "for it seems to me that only one of them can claim to possess a genuine picture by that great artist, namely the Gallery of the Accademia in Florence, with its large Madonna picture." Of Bellini, Dr. Richter says that in his capacity of State painter to the Republic of Venice it was his duty to execute the official portraits of the Doges. During his long life he saw eleven Doges, and was State painter during the reigns of four. In spite of this, only one likeness of a Doge by Bellini has been preserved, and that is the magnificent portrait of Leonardo Loredano in the National Gallery, which Dr. Richter describes as "one of the most perfect portraits of the Quattrocento, remarkable alike for the great simplicity of the conception, and for the brilliancy of the colouring."

General Notes.

Düsseldorf Exhibition, 1902. — Since 1880, the population of the Rhine and Westphalia provinces of Prussia has increased from 5,710,078 to 7,807,422, and is expected to attain 9,000,000 in 1902, in which year an industrial exhibition is to be held at Düsseldorf similar to that visited with so much interest by the Iron and Steel Institute in 1880. The North-West Group of Iron and Steel Makers, the Association of German Metallurgists and the Düsseldorf Association for Trade Interests have combined to give importance to the exhibition, for which the Municipality will furnish the land, and also contribute a guarantee fund.

Internal Navigation in Russia.—The total length of rivers and canals in European Russia —according to the *Revue de Statistique*, quoted in the *Board of Trade Journal*—is 67,596 miles, of which 46,202 miles are available for use, *i.e.*, 30,338 miles navigable and the remainder for floating purposes only. The canals aggregate 499 miles in length and canalised rivers 648 miles. The Volga alone accounts for nearly 50 per cent. of the navigable waterways. The average length of time for navigation varies naturally according to geographical distribution; it may be reckoned at about 158 to 220 days for the Neva and the Ladoga and Onega lakes; at from 221 to 240 days for the Niemen; at from 213 to 244 days for the Western Dwina, and at from 156 to 190 days only for the Northern Dwina. During the last five years the Russian Government has devoted nearly 150,000,000 francs (£6,000,000) to the improvement of navigable waterways. The goods carried are principally wood for building purposes, grain, petroleum, &c., salt, iron, coal, sugar, hemp, cotton, fish, and spirits.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, 4th inst., Professor F. Jeffrey Bell, M.A., delivered the first lecture of his course, addressed to a juvenile audience, the subject being "Hands and Feet."

The lecturer, after pointing out the differences in the functions and the resemblances in the structure of the hand and foot of Man, explained that this was an interesting example of the law known as the "Division of Physiological Labour." The resemblances and differences between a Man and a Gorilla were shown to be to the advantage of the former, and it was pointed out how, under the stress of circumstances, Man could put his foot to some of the uses to which the hand was generally devoted.

The marked differences between the foot of a man and of a horse were dilated on, and evidence was afforded that a continuous chain existed between early Eocene five-fingered *Phenacodus* and the one-fingered existing horse. The lecturer showed how this chain might be regarded as demonstrating gradual "evolution."

The fact that different animals attained the same result in different ways, was shown by the different structure of the wing in a bat or a bird, and, in conclusion, some of the more marked modifications of hands, such as that of the seal and of the mole, were briefly described.

The second lecture, on "Some of the Ways in which Animals Breathe," will be delivered on Wednesday evening next, 11th inst., at 7 o'clock.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

ACETYLENE.

By Vivian B. Lewes,

Professor of Chemistry, Royal Naval College, Greenwich.

Lecture III.—Delivered December 5, 1898.

Familiar as I have been with chemical actions of all kinds, more especially in the development and use of gases, I shall never forget the impression made on my mind when, in the autumn of 1894, I first generated acetylene by the action of water upon calcic carbide obtained from Mr. Willson, in America. There was something almost "uncanny" in the development of this wonderful gas from the simple contact of the carbide with water. I was the more impressed by it as I had spent several years in researches necessitating the making of considerable volumes of acetylene, and I realised to the full the laborious and unsatisfactory nature of all the earlier methods for its production. It was with this carbide that I then made the experiments detailed by me in this room in January, 1895, when I showed you for the first time in this country the reactions which had caused me such keen delight, and also showed for the first time in any country how the gas could be consumed so as to develop to the full its marvellous illuminating power.

In the generation of acetylene from calcic carbide and water, all that has to be done is to bring these two compounds into contact, when they mutually react upon each other with the formation of lime and acetylene, whilst if there be sufficient water present, the lime combines with it to form calcic hydrate.

$$(1.)\quad \begin{array}{rcccl} \text{Water.} & H_2 & & O & \text{Lime.} \\ & & \times & & \\ \text{Calcic carbide.} & Ca & & C_2 & \text{Acetylene.} \end{array} \quad \text{and}$$

$$(2.)\quad \underset{\text{Lime.}}{CaO} + \underset{\text{Water.}}{H_2O} = \underset{\text{Calcic hydrate.}}{Ca(HO)_2}$$

The wonderful simplicity of the reaction is its great beauty, and one would imagine that but little scope was afforded to the ingenuity of inventors in devising methods by which the contact between the interacting bodies should be brought about, but a glance through the patent literature of the last few years shows that where there is a will there's a way, and many of the weird devices protected under the

name of acetylene generators would lead one to suppose that the formation of this beautiful illuminant was one of the most complex problems ever submitted to the ingenuity of man.

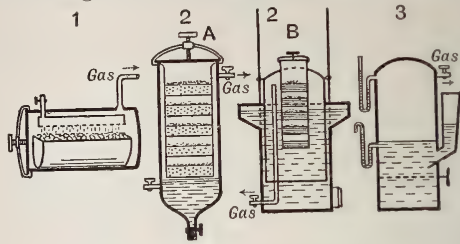
There are manifestly two methods by which the carbide and the water can be brought together—by adding either water to carbide, or carbide to water, whilst a slight amount of novelty can be introduced by allowing the water to rise in contact with the carbide from below, *i.e.*, by adding the water to the bottom of the carbide instead of the top.

I showed these three methods of procedure when I first described acetylene, and at the time thought that the question of generators was practically done with, but within a few months the idea arose of making automatic generators in which the space necessary for a small holder should be saved by making the apparatus only generate the gas as it was needed, and a multitude of devices for stopping the generation of the gas when the consumption ceased were designed and placed upon the market.

Unfortunately, the designers of these machines, although gifted with much ingenuity and mechanical skill, had but little idea of the properties of the body with which they were dealing, and as a result many of the generators, if not actually dangerous, are so arranged as to generate the gas in anything but its pure form, whilst some give a far smaller yield of gas per unit weight of carbide decomposed than others constructed on more rational principles.

The different forms of apparatus shown in the Exhibition at the Imperial Institute, held in the summer under the auspices of this Society, may be taken as representing the best types on the market, and when in a few weeks hence the report of the Committee is published, much interesting matter will be found in it. As a uniform quality of carbide was used throughout the Exhibition for over a month's continuous working, direct comparison between the performances of the various generators becomes possible.

In considering the various forms of apparatus it will be well to divide them, in the first place into two classes—(1) the *automatic*, in which the storage capacity for acetylene is less than the total volume of gas the charge of carbide is capable of generating, and which depend upon some special arrangement for stopping the action of water on the carbide when the consumption ceases; (2) the *non-automatic*, with which there is a holder of sufficient size to contain the whole of the gas generated from the charge of carbide which is used.



Each of these classes may be subdivided under three heads:—

1. Those in which water is by various devices allowed to drip or flow in a thin stream on to a mass of carbide, the evolution of the gas being regulated by the stopping of the water feed.

2A. Those in which water in volume is allowed to rise in contact with the carbide, the evolution of the gas being regulated by the water being driven back from the carbide by the increase of pressure in the generating chamber, or—

2B. by the rising bell of the gas-holder drawing the carbide up out of water.

3. Those in which the carbide is dropped or plunged into an excess of water.

The points to be attained in a good generator are:—

1. Low temperature of generation.
2. Complete decomposition of the carbide.
3. Maximum evolution of the gas.
4. Low pressure in every part of the apparatus.
5. Ease in charging and removal of residues.
6. Removal of all air from the apparatus before generation of the gas.

When carbide is acted upon by water considerable heat is evolved, and to determine what this amounted to, a good sample of commercial carbide containing 92 per cent. true carbide was experimented with as follows:—

A rough calorimeter was made by jacketing a beaker about 5 inches in diameter with cotton wool. This arrangement, though crude, answered its purpose well, as experiment showed that some hot water placed in it only lost ·2° C. after standing for ten minutes in a room at 18·6° C., a loss which could be neglected.

One piece of carbide, the weight of which was known, was dropped into a litre of water at a known temperature in the beaker, and the moment that the evolution of gas ceased, the temperature of the water was taken, the results being as follows:—

Grms. of water taken.	Grms. of calcic carbide	Rise in tempera-ture °C.	Corres-ponding calories liberated.	Number of calories liberated per gram of carbide.	Time of reaction in seconds.
1,000	42·7	17·4	17,400	407	62
1,000	28.9	11·4	11,400	394	91
1,000	19·7	8·2	8,200	416	73

which give, as an average, 406 calories liberated for each gram of carbide.

Broken up carbide, the pieces of which weighed from 1 to 5 grams, was thrown into a litre of water in the beaker in quantities of 30, 40, and 50 grams respectively—

Grms. of water taken.	Grms. of calcic carbide	Rise in tempera-ture °C.	Corres-ponding calories liberated.	Number of calories liberated per grm. of carbide.	Time of reaction in seconds.
1,000	50	17·6	17,600	352	248
1,000	50	18·4	18,400	368	86
1,000	50	18·3	18,300	366	123
1,000	50	18·4	18,400	368	106
1,000	40	15·6	15,600	390	109
1,000	40	15·8	15,800	395	101
1,000	40	15·0	15,000	375	196
1,000	40	15·5	15,500	387	110
1,000	30	11·7	11,700	390	76
1,000	30	10·8	10,800	360	89
1,000	30	11·8	11,800	393	114
1,000	30	11·4	11,400	380	85

or 377 calories liberated for 1 gram of carbide.

The last experiment was repeated with carbide still more finely divided, and the results gave 384 calories for each gram of carbide.

From these figures it will be seen that contrary to expectation, the smaller the carbide the less was the yield of heat, but the reason for this can soon be made evident. More time is spent in weighing out the finer carbide than in taking the weight of one large piece, and the larger surface presented by the small pieces, causes greater decomposition by the moisture in the air than with the single lump, hence the carbide is of poorer quality, and moreover the rapid evolution of gas in the case of the small carbide prevents the water abstracting all the heat from it.

Taking this into consideration, the 406 calories will most nearly represent the heat evolved by the decomposition of 1 gram of good commercial carbide, and this would be equivalent to 414·6 calories for pure carbide.

With this figure as a basis, it is evident that the action develops about one-twentieth of the heat evolved by the combustion of carbon. As, however, the intensity of the temperature developed is a function of the time needed to complete the action, and as the decomposition of the carbide by water is extremely rapid, and the degree of heat attained varies with every form of generator, whilst the water in one form may never reach the boiling point, the carbide in another may become red hot and give a temperature of over 800° C.

When water drips upon carbide as in generators of subdivision 1, the temperature rapidly rises until it reaches a maximum after about 18 to 25 minutes, the actual heat developed depending upon the rate of flow of the water and the way in which it is distributed over the mass, but it is quite possible with generators of this class to reach from 400 to 700° C., and it is probable that in some parts of the mass the higher limit is nearly always attained, traces of tar being generally found in the residual lime. In some cases it is in sufficient quantity to make the lime yellow and pasty, whilst vapours of benzene and other polymerisation products pass freely off with the gas.

Leaving the question of the temperature developed in this class of generator, another important point is the length of time over which generation of gas continues after the addition of water to the carbide has ceased. Makers of automatic apparatus of this type seem to think that in order to stop the evolution of acetylene, all they have to do is to cut off the water supply. This would act very well if the generation of gas really ceased then, but this is not the case, as the gas continues to be evolved, although with increasing slowness, for a considerable period after the cutting off of the water. The length of time over which this after-generation extends will of course, to a certain extent, depend upon the amount of water added, the amount of carbide undecomposed, and the temperature of the carbide at the time when the water supply is stopped; whilst the generation will itself depend upon—

(*a*). The dehydration of the calcic hydrate first formed.

(*b*). The decomposition of water condensed from the gas present as the temperature of the generator falls.

As we have before seen, the first result of the action of water upon the carbide is the formation of quicklime and the evolution of acetylene, whilst if sufficient water be present, the lime takes up another molecule of water to

form calcic hydrate. This molecule of water, however, at temperatures of 420-430° C., is driven off from the calcic hydrate, and the affinity of the carbide for any water present causes the reaction

$$CaC_2 + Ca(HO)_2 = 2CaO + C_2H_2.$$

A series of experiments was made by placing a known weight of carbide in a generating cylinder, running in a known weight of water in a given time, and carefully measuring the volume of gas for the first ten minutes, and again when the action had practically ceased, and not more than 1 cc. of gas was evolved in ten minutes.

The results so obtained showed clearly that in any apparatus on this principle the cut off should be so arranged that at least one-fourth of the total holder capacity is still available to store the slowly generated gas.

An important point was noticed in these experiments, viz., the large excess of water required to ensure complete decomposition of the carbide over and above the theoretical quantity. The excess of water needed was largely dependent upon the form of generator employed.

According to theory 64 parts by weight of carbide require only 36 parts by weight of water to completely decompose them and convert the lime into calcic hydrate.

This would mean that each pound of carbide needs a little under half a pint of water to complete the action, whilst in practice, owing to the evaporation due to the heat of the action, half the added water is driven off as steam with the acetylene, or left mechanically adhering to the lime, and the smallest quantity likely to complete the action would be a pint to a pound of carbide, whilst in reality the only safe way is to add sufficient water to drown the residue.

If this is not done the lime forms so protective a coating to the carbide that small quantities often remain undecomposed, and if the residues are thrown into a drain or cesspool, the evolution of acetylene would give an explosive mixture which, on account of its low point of ignition, would be a serious danger.

The second subdivision of generators (2A), in which water rises to the carbide, is very popular, and over-heating can be avoided in these, provided they are so arranged that the water is never driven back from the carbide, and if the charge of carbide used is not too great. Under these conditions the slowly rising water is always in excess at the point where it decomposes the carbide, so that the evaporation by rendering heat latent keeps down the temperature, and although the steam so formed partly decomposes the carbide in the upper portion of the charge, the action is never sufficiently rapid to give any very great rise of temperature. In order to fulfil these conditions it is necessary that there should be a holder of considerable capacity, and that the leading tube conducting the gas from the generator to the holder should be of sufficient diameter to freely conduct away the gas, the water being allowed at the same time to rise in the generator so slowly as to do away with any risk of over-generation.

In the best generators of this class these conditions are more or less approached, and it is unusual to find that the melting point of tin, 228° C., has been reached in the charge of carbide during decomposition.

Where apparatus of this class are automatic and have no rising holder to take the gas, it is found that they work satisfactorily when supplying the number of lights for which they were designed; but if they are over-driven and the action becomes too violent, excessive heating takes place, whilst the turning off of the gas and consequent driving back of the water from the carbide also has a tendency to cause it. If, however, the water has risen sufficiently slowly, the carbide below the surface has been practically all decomposed, so that the heating only takes place over a limited zone.

The generators of subdivision 2B are the worst offenders as regards excessive heating, the charge of carbide in some of them frequently becoming red hot, whilst the lime taken from them is highly coloured and often black from the formation of tar and carbon.

The moment that acetylene is subjected to the action of high temperatures changes of great complexity begin. These at first are purely synthetical; at temperatures which are comparatively low the acetylene begins to condense to benzene; as the temperature rises the condensation of four molecules of acetylene yields styrolene; a further increase in the temperature may cause the styrolene and benzene to interact, yielding anthracene and hydrogen, and it is probably at this point that the brown tar vapours appear, while naphthalene also is formed. At this temperature, moreover, a fresh set of interactions start, the nascent hydrogen combines with acetylene to form ethylene, and this body under the action of heat breaks down into methane and acetylene once more.

When the outer layer of carbide decomposes, the gas is evolved so rapidly that there is no time for the heat to act upon it, but as the decomposition spreads into the centre of the mass, the acetylene generated has to pass through the external layers, which as shown may be at a temperature above the point of its decomposition, and it is under these conditions that a considerable volume of gas is lost, and the tar, often found in the residue, or distilled out into the generator and tubes, is formed.

In generators in which excessive heating takes place, the tar is likely to cause considerable trouble, as it is of a very viscid nature, and if it condenses in the delivery tubes causes the lime dust and carbon particles to collect and bring about stoppage.

A still more important evil, however, is to be found in the alteration which takes place in the composition of the gas, and which reduces its illuminating value to a serious extent.

Two samples of gas taken whilst the charge in one of these generators was over-heating gave the following results on analysis :—

	Per cent.	Per cent.
Acetylene	70·0	69·7
Saturated hydrocarbons	11·3	11·4
Hydrogen	18·7	18·9
	100·0	100·0

and such a mixture would only have about one-half the illuminating value of pure acetylene.

The large amount of hydrogen present in these samples also shows that decomposition of some of the acetylene has taken place, and a considerable deposit of carbon is often found in the generator.

At first sight these results seem an absolute condemnation of the second subdivision of apparatus, and the rising bell which draws a mass of wet carbide above the surface of the water is bad from every point of view. But generators in which water rises from below and so attacks the carbide can be made safe if the arrangements are such that the water is never driven back from the carbide, and the bulk of carbide is sufficiently subdivided.

The generators of the third class are those in which carbide is allowed to fall into an excess of water, and these have many advantages.

In such generators, as long as there is water present, it is impossible to get above a temperature of 100° C., unless lime sludge is allowed to collect at the bottom, when the carbide will sometimes get hot enough to melt zinc, but with a properly arranged tank the temperature never exceeds the air temperature by more than a few degrees. Under these conditions, the absence of polymerisation and the washing of the nascent and finely-divided bubbles of gas by the lime water in the generator yields acetylene of a degree of purity unapproached in any other form of apparatus.

The one thing that has militated against it is that it is not easy to design such a generator which shall be automatic, and as this seems to be the craze from which the generator makers are at present suffering, its advantages have been apparently overlooked by them, although fully recognised by all scientific men.

This form of generator, however, although exhibiting the great advantages enumerated above, has the drawback of being one of the least economical in the output of acetylene per pound of carbide used, as the gas having to bubble through the water is rapidly dissolved by it, whilst in an apparatus in which only the surface of the water touches the gas, the amount dissolved is comparatively small. The result of this is that with generators of this class the generation rarely exceeds 4·2 cubic feet of acetylene per lb. of carbide instead of 5 cubic feet per lb.

As regards the complete decomposition of the carbide, it has been already pointed out that in generators of the first subdivision there may be a small quantity of the carbide left undecomposed if water enough to flood the residuum be not admitted, whilst in non-automatic generators of the second subdivision this is practically impossible. In generators of the third subdivision, in which carbide drops into a large excess of water, it might be imagined that any carbide in the residue was an impossibility, but in point of fact this class is often the worst offender in this respect, as, if the generation has been in action for some time, a thick sludge of lime collects at the bottom of the generator into which the carbide sinks, and a large lump of carbide will often make for itself so tough a layer of oil and lime, that it resists the action of the water, and is found unacted upon when the generator is cleaned out, the usual explanation given by the generator-maker being that it is crust present in the "bad carbide."

In a good generator the maximum yield o gas should be evolved from the carbide. But a fact which the generator-makers have entirely overlooked up to the present time is, that if you take a number of different machines, and supply them all with exactly the same carbide, no two will give the same yield of gas; the

best generators giving volumes approximating to 5 cubic feet per lb. of carbide, whilst the worst will give barely four, a result, as usual, placed at the door of the carbide.

The causes which tend to diminish the volume of acetylene given off are :—

1. Undue pressure in the generator.

2. The acetylene after generation having to pass through a column of water.

3. Undue heating causing polymerisation.

The first of these is very noticeable, and is due to the increased volume of gas dissolved by water under pressure, as although ten volumes of water at ordinary atmospheric pressure only dissolve eleven volumes of acetylene at two atmospheres pressure it dissolves double the quantity.

When acetylene is generated at or above the surface of water, but little dissolves at once, the top layer of water rapidly becomes saturated, but when the gas has to bubble up through a mass of water, as in generators of the third class, a heavy loss from solution takes place.

The last cause has already been discussed, and is not so noticeable in its result.

The pressure in all parts of a generator should be as nearly as possible equal and as low as possible, and this is best obtained by working freely into a gas-holder of sufficient size.

The Home Office fixed 100 inches of water as the limit of pressure permissible in generators, but I think myself it was a mistake to allow more than 20, and I certainly should not advise the use of a generator which gave more than that amount.

Every part of the generator should be easily accessible, and complicated taps and valves should be avoided, whilst ease of charging and clearing should be attended to, ample room being provided in the generator for the increase n bulk which takes place when carbide is converted into lime.

One pound of pure calcic carbide yields 1·15 lbs. of slacked lime – one kilo of carbide yields 1,156 grams of slacked lime—and the volume this will occupy depends entirely upon the way in which the water is brought into contact with it.

In an automatic generator of the first subdivision where water drips slowly upon the carbide in sufficient quantity to decompose it but not to flood it, the lime swells up and occupies from 2 to 2·5 times the bulk of the original carbide; when, however, the water flows in more rapidly, the impact of the water beats down the lime and the space occupied is large.

In generators of the second type, in which water rises from below, the weight of the undecomposed carbide above it presses down the lime below and keeps it in a compact mass occupying about one-half more space than the carbide from which it was formed.

In designing a generator of the third subdivision, the tank containing the water into which the carbide falls should be provided with a false bottom so as to leave at least 8 inches to 1 foot of water below the point at which the carbide is decomposed for the lime sludge to settle in, and experiments were made to see the rate at which the settling of the excess of lime took place.

In these experiments known weights of calcic carbide were dropped into a beaker containing a litre of water, and the results obtained were as follows :—

Water taken.	Calcic carbide.	Volume of Lime Paste deposited.		Volume of Lime Paste deposited, calc. for 1 grm. CaC_2.	
		30 mins.	90 mins.	30 mins.	90 mins.
Grms.	Grms.	c.c.	c.c.		
1,000	50	480	360	9·6	7·2
1,000	50	470	340	9·4	6·8
1,000	50	440	350	8·8	7·0
1,000	50	470	370	9·4	7·4
1,000	40	430	330	10·7	8·0
1,000	40	420	320	10·5	8·0
1,000	40	400	310	10·2	7·7
1,000	40	410	320	10·5	8·0
1,000	30	340	240	11·0	8·0
1,000	30	320	220	10·3	7·3
1,000	30	330	240	11·0	8·0
1,000	30	330	240	11·0	8·0
			Mean	10·2	7·6
1,000	50	450	340	9·0	6·8
1,000	50	440	330	8·8	6·6
1,000	50	450	330	9·0	6·6
1,000	50	440	320	8·8	6·2
1,000	40	390	310	9·7	7·7
1,000	40	410	310	10·0	7·7
1,000	40	390	300	9·7	7·5
1,000	40	390	300	9·7	7·5
1,000	30	310	210	10·3	7·0
1,000	30	300	240	10·0	8·0
1,000	30	240	230	9·6	7·6
1,000	30	300	220	10·0	7·3
			Mean	9·8	8·6

After 30 minutes the volume of lime was 10

c. per gram of carbide. After 90 minutes e volume of lime was 8·1 c.c. per gram of rbide. So that approximately after an hour's anding, each kilo. of calcic carbide will give litres of lime sludge, or 1 lb. of calcic carde will yield eight pints, which can be got l of by a cock at the bottom of the apparatus. ie rapidity with which settling takes place , of course, slightly affected by the form of e apparatus.

Another requisite of a good generator, overoked up to the present time, is that there iould be an arrangement by which the air esent in the generator can be rinsed out with me of the acetylene already made in the older, or by some inert gas like carbon oxide. I think this is a most important preution, as recent researches by Mr. H. Gerdes iow that, instead of acetylene requiring to be luted with about twelve times its bulk of air order to obtain the maximum pressure on xplosion, mixtures of equal volumes of acelene and air give the most powerful result. must be remembered that the temperature which acetylene decomposes into carbon and ydrogen with evolution of heat is 780° C., it the temperature of ignition is 480° C., and such a mixture the degree of heat needed cause explosion will more nearly approach e latter than the former temperature. It quite conceivable that in working on a big ale, the carbide might easily reach the ecessary temperature whilst such a mixture acetylene and air still remained in contact th it; indeed I have come across several ises of explosion which could only be exained by this.

Working with 90 litres of the various mixtures an explosion cylinder, and measuring the essures by means of a manometer and incator, the following results were obtained:—

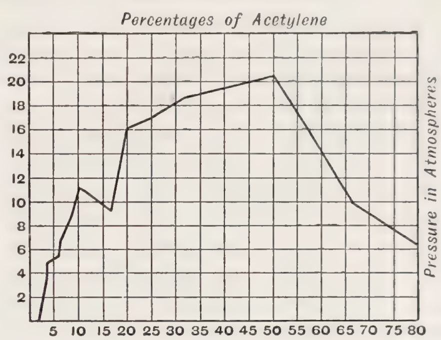
essures given by exploding mixtures of Acetylene and Air.

r-centage Acetylene.	Atmospheres Pressure.	Per-centage of Acetylene.	Atmospheres Pressure.
2·5	0·05	11·1	11·1
3·7	3·7	12·5	10·6
4·7	4·9	16·6	7·2
5·5	5·2	20·0	16·0
6·6	6·8	25·0	16·9
7·7	8·2	33·0	18·4
8·3	8·6	50·0	20·3
9·1	9·7	66·0	10·0
10·0	11·1	80·0	6·3

If these results be plotted out in a curve, it ll be seen that there are two maxima of plosive force.

The first maximum of pressure occurs when completed combustion yields the greatest heat effect, and the acetylene is burned to carbon dioxide and water vapour, and this mixture explodes with the greatest noise.

Mr. Gerdes explains the second maximum of pressure by the assumption that the carbon is gaseous at the moment of liberation, but I do not think this theory is tenable. If a mixture of equal volumes of acetylene and air be ignited in an open cylinder 18 inches high a lurid disc of flame runs down the cylinder and a vast cloud of carbon is given off, but no sign of anything approaching explosion occurs. If, however, this be done in a closed vessel the very slowness of the combustion brings about the explosion, as the combustion of the portion of the mixture first ignited creates a pressure under which the remainder detonates at the temperature of combustion and gives the high pressure noticed in these experiments.



In experiments which I have made I have found it extremely difficult to ignite such a mixture of air and acetylene in a tube by means of an electric spark, but if a flask be employed so that a considerable volume of the mixture be present, the spark at once causes a violent explosion, the finely divided particles into which the glass is blown being an ample proof of the explosive force having been of an extremely sharp character.

The fact that a mixture of one volume of air and one volume of acetylene burns extremely slowly in an open cylinder, and also the fact that it is difficult to ignite by a spark the mixture in small portions, is no argument against the explosibility of the mixture, as if you take a mixture of carbon disulphide and nitric oxide in a short cylinder it burns with simply a bright flash of light which is noted for its richness in actinic rays, whereas if a very long narrow cylinder be employed, it burns down to a certain point and then detonates,

blowing the cylinder to pieces, such phenomena being entirely due to the increase in rapidity of combustion which finally terminates in an explosive wave.

A good deal of the trouble arising in generators is due to the irregular development of the acetylene, which at first comes off with tremendous rapidity, and then as the exterior carbide becomes coated with lime gets slower and slower, whilst the after cracking-off of this coating then gives irregular rushes of gas. Many attempts have been made to get over this trouble, perhaps the most successful being the decomposition of the carbide by means of a solution of sugar, which has the power of dissolving the lime as it is formed, and so gives a uniform and less rapid evolution of gas, but of course this increases the expense, and would only be available in the generators of table and bicycle lamps where cost is a secondary consideration; alcohol also when mixed with the water tends to regulate the generation. The effect of various oils in regulating the evolution of the gas has also been tried with a certain amount of success; as, if the carbide be coated with oil, it is protected from the action of water all the time the oil is clinging to the material; and in one form of automatic generator a layer of light oil is placed on the surface of the water. As the water rises past the carbide the oil rises with it, and the action of the water on the carbide commences a few minutes after the water has come into contact with it and has had time to displace the oil, whilst on cutting off the gas the water is again driven down. As the oil on its surface comes in contact with the partially decomposed carbide it is supposed to coat it and stop the after generation. With very small generators working well within their capacities this may be successful, but with any large charge of carbide the heat remaining in the lumps of solid material would probably be sufficient to distil out some of the light oil employed.

In concluding this part of the subject I can only say that I believe that as time goes on the tendency on the part of acetylene consumers will be to use the simplest form of generator available with a holder proportionate to the needed consumption.

Abroad, a good deal of work has been done on the purification of acetylene, and although this is desirable with the smallest installation, it becomes imperative when small towns or villages are to be supplied with acetylene instead of coal gas.

As was pointed out in the last lecture t purity of the acetylene gas primarily depen upon the purity of the carbide from which it formed, and as long as it is commercially i possible to use absolutely pure calcic oxide a carbon, so long will there be always present this material calcic phosphide, calcic cyani aluminium sulphide, and magnesium nitri which, on the decomposition of the mass water, will yield a gaseous and unwelco addition to the acetylene of phosphuretted hyd gen, sulphuretted hydrogen, and ammonia.

Phosphuretted hydrogen, when it burns the acetylene flame, gives rise to phosphor pentoxide, which escapes into the atmosphe in the form of white fumes, and although t quantity is so minute that it is invisible as leaves the acetylene flame, still, when mingl in quantity with the air of an ill-ventilat room, it is the primary cause of the producti of a light haze which ever since the introdu tion of acetylene for illuminating purposes, h been recognised as a serious inconvenience connection with it.

The atmosphere of a warm room always co tains large quantities of water vapour deriv both from the respiration of the occupants a from the products of the combustion of t illuminating flame, and under ordinary con tions this moisture remains suspended in t atmosphere in an invisible state, but as so as traces of phosphorus pentoxide esca into it, this substance having a marvello affinity for water, causes a condensation of portion of the water vapour and converts it in phosphoric acid, so that a very small trace phosphuretted hydrogen in the gas itself gi rise to an amount of haze totally out of pr portion to the actual phosphorus prese Where there is a considerable quantity acetylene consumed and no proper method changing the air of the room, this haze w often be found, and it is undoubtedly injurio to health. I do not myself think that the wh of the onus of the haze can be laid at the d of the phosphuretted hydrogen in the acetyle but it undoubtedly plays an important part this action upon which I am at present expe menting.

The sulphuretted hydrogen formed by t action of water on the aluminium sulphide the gas is objectionable, not so much becau it renders the smell of the acetylene offensive function which I look upon a safeguard, b because in its combustion in the acetyle flame it forms sulphur dioxide, which in i ventilated apartments will absorb moisture a

:ygen from the air, and will in this way :come converted into minute traces of sul- ıuric acid which, concentrating themselves pon any cold surface in the room in the form ' impalpable moisture, give rise to corrosion of etals and in time to destruction of the binding ' books, although the effect is but small upon ıch fabrics as have not the power of absorbing oisture or condensing it from the atmosphere.

The chief objection to the third impurity ·esent in the acetylene gas ammonia is that it ads to rapid action upon the brass gas ttings, and is also an important factor in pro- ucing explosive compounds of acetylene with etals, although the experiments of Mr. Gerdes ıve shown that this is not a very real danger. The ammonia, on burning in the flame, also ›rms nitrous acid, and when acetylene is urnt for some time in an enclosed space mmonic nitrite can be detected, and salts of ıis character may add to the formation of the haze."

It is quite clear, however, that acetylene, if it ; to be used on a large scale as a domestic luminant, must undergo such processes of urification as will render it harmless and ınocuous to health and property, and the ›oner it is recognised as absolutely essential › purify acetylene before consuming it, the ›oner will the gas acquire its deserved mead ' popularity, whilst I think I shall be able to ıow in the next lecture that many other ·oubles will at the same time be overcome.

The only one of the impurities which offers ny difficulty in removal is the phosphuretted ydrogen. There are three substances which an be relied on to more or less remove this com- ound. The three methods are to pass the gas › be purified either through acid copper salts, ırough bleaching powder, or through chromic cid, and in experiments with these various odies, it is found that they are all of them fective in also ridding the acetylene of the mmonia and sulphuretted hydrogen, provided ıly that the surface area presented to the gas ; sufficiently large.

The method of washing the gas with acid ›lutions of copper has been patented by Herr . Frank, of Charlottenberg, who finds that a ›ncentrated solution of cuprous chloride in an :id, the liquid being made into a paste with eselgühr, is the most effective to be employed, ıd where the production of acetylene is going ı on a small scale this method of purifying is ıdoubtedly the most convenient one, as the :id present absorbs the ammonia, and the ›pper salt converts the phosphuretted and sulphuretted hydrogen into phosphates and sulphides. The vessel, however, which contains this mixture has to be of earthenware, porcelain, or enamelled iron, on account of the free acid present; the gas must be washed after purification to remove traces of hydrochloric acid, and care would have to be taken to prevent the complete neutralisation of this acid by means of ammonia.

The second process is one patented by Dr. Ullmann, of Geneva, who utilises chromic acid which oxidises the phosphuretted and sulphuretted hydrogen and absorbs the ammonia; whilst the third process owes its inception to Lunge, who recommends the use of bleaching powder for the purification of acetylene: but Dr. Wolff has found that when this is used on a large scale there was a risk of the ammonia present in the acetylene forming traces of chloride of nitrogen in the purifying boxes, and as this is a liquid which detonates with considerable local force, it occasionally gives rise to explosions in the purifying apparatus. If, however, the gas be first passed through a scrubber so as to wash out the ammonia, this danger is got rid of, and Dr. Wolff employs purifiers in which the gas is washed with water containing calcic chloride and is then passed through bleaching powder solution or other oxidising material.

The form of apparatus employed in the generation of acetylene has a remarkable influence upon the proportion of sulphuretted hydrogen and ammonia present in the gas, although it affects but little the quantity of phosphuretted hydrogen. A long series of experiments which I have made shows that when the acetylene is generated in machines of the third subdivision the ammonia is entirely eliminated, whilst the passage through the lime water reduces the amount of sulphuretted hydrogen present to a mere trace, which may be neglected, but has little or no effect upon the phosphuretted hydrogen.

Analyses given by Dr. Wolff of acetylene generated from American, German, and Swiss carbide as at present made give the following results:—

	American.	German.	Swiss.
Phosphuretted hydrogen	0·05	0·03	0·03
Sulphuretted hydrogen	0·08	0·07	0·10
Ammonia	0·08	0·07	0·11
Hydrogen	0·09	0·07	0·16
Nitrogen..............	0·42	0·20	0·34
Oxygen	0·87	0·55	0·63
Acetylene	98·41	99·01	98·63
	100·00	100·00	100·00

whilst analyses which I have lately made from the ordinary commercial English carbide, and from the pure carbide made in France in the Herolt furnace by tapping process, are as follows:—

	English carbide.	French carbide.
Phosphuretted hydrogen....	0·138	0·045
Sulphuretted hydrogen	0·064	0·048

On taking a sample of English carbide and decomposing it by the dripping process there is found 0·138 per cent. of phosphuretted hydrogen, and 0·064 per cent. of sulphuretted hydrogen; whilst if this carbide is allowed to fall into water, the acetylene so generated contains 0·126 per cent. of phosphuretted hydrogen, and the sulphuretted hydrogen is practically eliminated.

When the carbide is dropped into a solution of sugar the same result is obtained, and practically no sulphuretted hydrogen can be detected in the gas so generated.

Miscellaneous.

WORKMEN'S DWELLINGS IN GERMANY.

The United States Consul at Chemnitz writes that there is a movement on foot to furnish working men with better dwelling places in Germany. At present they are crowded into buildings which often look like barracks. The proposed houses will be built upon plots of ground about 16½ feet wide by 102 feet deep, thereby allowing for a front yard for flowers and a back yard for a vegetable garden and shed, the latter for the keeping of poultry or some domestic animal. The houses will contain five rooms. A parlour and kitchen will be on the first floor, the parlour containing a porcelain stove and heating pipes; and the kitchen, a wash boiler and stove. The three bedrooms on the second floor will easily hold five or six persons and can be made to accommodate ten. In the largest, an iron stove will be placed. A pump will provide water where the city waterworks do not extend to the house. The cost of such a house and plot of ground when a number are built at a time will be between £170 and £190. It will let for about £9 a year—that is for the same price the working man has to pay for two rooms in the barrack-like tenements of the large cities.

PRODUCTION OF BEER IN HAMBURG.

There are at present fifteen large breweries in and near Hamburg, the aggregate capital of which amounts to about £1,000,000. It is stated that all these breweries together produce annually a litt over 22,000,000 gallons of beer, but that this quanti could, if required, be easily increased by 8,000,000 9,000,000 gallons per annum. Consul-General Wa says that by far the greater portion of these 22,000,00 gallons is consumed in the district itself, only a com paratively small proportion of the Hamburg-mad beer being exported to foreign countries by sea, or l land to the interior of Germany. The beer made f exportation is of a stronger quality than that co sumed on the spot, and it is mostly subjected "Pasteurisation," especially when destined for shi ment to hot climates. Most of the beer brewed Hamburg is of a light colour and medium strengt and is brewed on the same principles as other go German beer; a small quantity of porter and ale imitation of the English is also brewed at Hambur chiefly for exportation. All the Hamburg breweri are stated to be fitted with the newest and best brewin machinery. It appears, according to an article recentl published in the leading Hamburg commercial pape that the quantity of beer annually exported by lan and sea from all parts of Germany has been graduall diminishing during recent years. The total value c these exportations, in 1897, was about 950,000, whil in 1885 their total value is stated to have largely ex ceeded that fignre. The value of the exportations b sea from Hamburg alone fell from £748,061, in the yea 1889, to £498,310 in 1897. This decline in th annual exportation of beer from Germany has bee due, on the one hand, to the gradual falling off c the demand in France, which country, it may b observed, has always been, and still is, the best cus sumer for German beer, but which, during the las ten years, has largely increased its own beer produc tion by the introduction of improved brewing method The exportation of German beer to France, and als though to a minor extent, to Belgium and Hollan (for shipment from Antwerp and Rotterdam, respec tively, to oversea countries) is still of considerable im portance; but these exports being, like those to mos other parts of continental Europe, effected by lan they of course do not affect Hamburg. The greate proportion, however, of the entire German seaborn beer exportations pass through, or are made from th port, whilst only a comparatively small share of thi export trade is in the hands of Bremen-Bremerhaven and the quantity of beer annually shipped fron German Baltic ports is quite inconsiderable. Ham burg is indeed, at present, the most important con tinental port for the shipment of German and also o some quantities of Austrian beer, as well as of som small amounts of British, Norwegian, and Danis beers. Of the German beer exported hence, a certai proportion is brewed at Hamburg, the remainde being chiefly of Bavarian origin. The Austrian bee comes nearly all from Pilsen in Bohemia. The expor trade of beer from Hamburg, both of that brewed in the district, and that produced elsewhere in Ger many, which had experienced a remarkable develop ment between 1880 and 1890, has of late years lost

uch of its importance in consequence of the growg competition in various oversea countries, where eweries have been erected, and where, owing to the iproved refrigerating machinery now employed, iod beer can be produced, even in tropical countries. he excessive production, moreover, at Hamburg, as ell as in most other parts of Germany, has depressed ices to such an extent that the profits formerly ijoyed by the export trade have dwindled to almost ithing. Australia and the Cape Colony have conued during the last two years to be the best markets r German beer, next to the United States and ritish India; but the recent extensive exportations om Hamburg to Australia of various sorts of achinery used for making beer, would seem to int to the probability of some parts of the Ausalian continent soon being able to provide for their vn wants in this respect.

Correspondence.

TRANSMISSION OF ELECTRIC POWER.

Professor GEORGE FORBES writes :—" Referring to ie suggestion made in my recent lecture to the ociety of Arts that the copper used in electric orks should be mortgaged, I find that the mention made of Mr. Thwaite's name in a subsequent otice in the *Journal* (see *ante*, p. 103), led some eople to believe that he was the originator of the heme. This is not the case; my attention has een drawn to the facts that his paper was read on ie 12th November, 1892, and that in my Cantor ecture to the Society of Arts on the 25th January, 892, I had said "That far more copper would be it down in mains if people realised the low rates at hich money could be raised in debentures on them."

Obituary.

EUGEN OBACH, PH.D.—Dr. Obach, whose imortant series of Cantor Lectures on "Gutta ercha" was delivered before the Society of Arts November and December, 1897, died at Graz, Styria, on 27th December, 1898, after a long ness. Eugen Obach was born at Stuttgart, in 'urtemberg, in April, 1852, of Swiss parentage, s father being an artist. He was educated at the eal and Polytechnic Schools of his native town, id from 1873 he continued his studies in natural ience at the University of Leipzig, where he obined his doctor's degree. In 1875 he began s practical career in the house of Messrs. Siemens d Halske, at Charlottenberg, near Berlin, and in the following year he came to England to occupy a position in the English firm of Messrs. Siemens Bros., at their Telegraph Cable Works at Woolwich. In 1879 he accompanied the expedition for laying the Trans-Atlantic Cable in Messrs. Siemens's s.s. *Faraday*. Afterwards he devoted himself mainly to the study of the chemistry of gutta-percha and india-rubber, his extensive knowledge of the former substance being embodied in his Cantor Lectures. He was also the author of many papers on electrical and other subjects in foreign and English journals. Dr. Obach was elected a member of the Society of Arts in 1880.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

JANUARY 18.—" Canals and Inland Navigation in the United Kingdom." By L. F. VERNON-HARCOURT, M.A. Sir E. LEADER WILLIAMS will preside.

JANUARY 25.—" Tuberculosis in Animals." By W. HUNTING.

FEBRUARY 1.—" The Cost of Municipal Enterprise." By DIXON H. DAVIES. The ATTORNEY-GENERAL will preside.

FEBRUARY 8.—" Leadless Glazes." By WILTON P. RIX.

FEBRUARY 15.—

FEBRUARY 22.—" Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

Dates to be hereafter announced :—

" Liquid Fuel." By Sir MARCUS SAMUEL.
" Preservation of Timber." By S. B. BOULTON.
" Coal Supplies." By T. FORSTER BROWN.
" Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.
" London Water Supply." By WALTER HUNTER, M.Inst.C.E.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

JANUARY 19.—" Railways in Burma and their Proposed Extension across Yunnan." By J. NISBET, D.Sec. Conservator of Forests, Burma. Sir ALEXANDER MACKENZIE, K.C.S.I., late Lieutenant-Governor of Bengal, will preside.

FEBRUARY 9.—" The Penal System at the Andamans." By Colonel RICHARD CARNAC TEMPLE, C.I.E., Chief Commissioner of the Andaman Islands.

MARCH 9.—" Leprosy in India." By H. A. ACWORTH, C.I.E., late Government Municipal Commissioner for the City of Bombay.

APRIL 13.—"Judicial Reforms in Egypt in Relation to the Indian Legal System." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive.

MAY 11.—"The Port of Calcutta." By SIR CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

MAY 25.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

The meetings of January 19, February 9, and March 9, will be held at the Imperial Institute; those of April 13, May 11 and 25, at the Society of Arts.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

JANUARY 24.—"Rhodesia and its Mines in 1898." By WILLIAM FISCHER WILKINSON, F.G.S., Assoc. M.Inst.C.E. The Hon. Sir DAVID TENNANT, K.C.M.G., Agent-General for Cape Colony, will preside.

FEBRUARY 28.—"Persian Trade Routes." By A. HOTZ.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

JANUARY 31.—"The Centenary Exhibition of Lithographs, with remarks on further Developments of the Art." By EDWARD F. STRANGE.

FEBRUARY 21.—"Vitreous Enamels." By CYRIL DAVENPORT.

MARCH 14.—"Craftsmanship and its Place in a National Scheme of Art Culture. By Sir WILLIAM BLAKE RICHMOND, K.C.B., R.A.

APRIL 18.—"Modern Changes in Taste relating to Domestic Furniture." By GEORGE LOCK.

MAY 2.—"Maiolica." By WILLIAM BURTON.

MAY 30.—"Wrought Iron Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

LECTURE I.—JANUARY 16.

Primitive methods—Earth disposal—Cesspools—Infiltration through soil—Water-carriage—Pollution of rivers and effects of dilution—Irrigation—Early results.

LECTURE II.—JANUARY 23.

Recognition of the function of bacteria, and researches on them—Massachusetts, Barking, and Sutton experiments—Schemes for aeration: Lowcock, Waring, Ducat—Materials—Garfield's coal filter—Manchester and Leeds experiments.

LECTURE III.—JANUARY 30.

Anærobic preparation—Mouras' automatic scaveng[er] —Moncrieff's earlier experiments—Exeter septic tan[k]

LECTURE IV.—FEBRUARY 6.

Differentiation of the organisms—Scott Moncrief[f] later process — Nitrification and nitrosification Adeney's "oxygen system"—Conditions for aerob[ic] and anaerobic change, and criteria for judging t[he] purity of effluents—Resumé and suggestions.

ARCHIBALD SHARP, A.M.Inst.C.E., "Cyc[le] Construction and Design." Four Lectur[es]. February 20, 27, March 6, 13.

PROF. HENRY R. PROCTER, "Leather Man[u]facture." Four Lectures. April 10, 17, 24, May 1.

MEETINGS FOR THE ENSUING WEE[K]

MONDAY, JAN. 9...Imperial Inst., South Kensington, 8½ p[.m.] Mr. Arthur Diosy, "The New Far East in [its] Relations to the British Empire."
Surveyors, Savoy-street, W.C., 8 p.m. Disc[us]sion on the paper by Mr. Wm. Weaver, "[The] London Building Act and the Official Sup[er]vision of Buildings."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 4 p[.m.] (Juvenile Lecture.) Mr. J. W. Rudler, "[The] Records of the Rocks."

TUESDAY, JAN. 10...Medical and Chirurgical, 20, Hanov[er]-square, 8½ p.m.
Civil Engineers, 25, Great George-street, S.[W.], 8 p.m. Mr. J. H. Dales, "High Speed Engines."
Photographic, 12, Hanover-square W., 8 p.m.
Anthropological, 3, Hanover-square, W., 8½ p.m.
Biblical Archæology, 37, Great Russell-street, W[.] Annual Meeting.
Asiatic, 22, Albemarle-street, W., 4 p.m.
United Service Institution, Whitehall, S.W., 3 p[.m.] (Juvenile Lecture.) "The Navy during the R[eign] of Queen Victoria."

WEDNESDAY, JAN. 11...SOCIETY OF ARTS, John-str[eet], Adelphi, W.C., 7 p.m. (Juvenile Lecture.) P[rof.] Jeffrey Bell, "Some Ways in which Anim[als] Breathe."
Royal Literary Fund, 7, Adelphi-terrace, W.[C.], 3 p.m.
Royal Society of Literature, 20, Hanover-squ[are], W., 1 p.m.

THURSDAY, JAN. 12...Antiquaries, Burlington-house, [W.], 8½ p.m.
Electrical Engineers, 25, Great George-street, S.[W., 8] p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JAN. 13...Civil Engineers, 25, Great George-str[eet], S.W., 8 p.m. (Students' Meeting.) Dr. A. B[...], "The Application of the Science of Mechanic[s to] Engineering Practice."
Astronomical, Burlington-house, W., 8 p.m.
Philological, University College, W.C., 8 p.m.
Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, JAN. 14...Botanic, Inner Circle, Regent's-pa[rk], N.W., 3¾ p.m.

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FRIDAY, JANUARY 13, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

SWINEY PRIZE.

The adjudicators under the will of the late Dr. Swiney are summoned to meet at the house of the Society of Arts, John-street, Adelphi, London, on Friday, the 20th January, 1899, at 4 p.m., to make the award in conformity with the terms of the bequest contained in the will of the testator.

(By order),

Henry Trueman Wood,
Secretary.

JUVENILE LECTURES.

On Wednesday evening, 11th inst., Prof. Jeffrey Bell delivered the second and last lecture of his course addressed to a juvenile audience, the subject being "Some Ways in which Animals Breathe." The lecturer, after reminding his audience of the results of being in a "stuffy" room, and of the advantages of fresh air, pointed out that what was called fresh air was wanted by every part of the body, by the toes no less than by the brain.

The essential part of the air in breathing is oxygen, and the problem is how is this gas conveyed all over the body?

The mechanism is two-fold: first there is a pumping and circulating apparatus which, in man, unceasingly drives blood through the body; this blood contains among other things corpuscles impregnated with a special compound called hæmoglobin. This has an avidity for oxygen, but is equally prone to give it up. The corpuscles start then on their journey conveying "oxy-hæmoglobin;" they return with "reduced hæmoglobin." Colouring matters equally capable of existing in two conditions of oxidation are found in various invertebrate animals, and it is probable that they also serve in the processes of respiration.

The process of physiological division of labour is to be seen in the organs of respiration; some animals, like the starfish, have the whole surface covered with little sacs, which merely separate the sea-water from the fluid of the body-cavity. Others, like oysters, have several plates of considerable size, while the lobster has a definite series of gills placed in a definite cavity.

In insects and their allies air-tubes penetrate between the organs of the body and carry the air to them; in these the blood takes no part n oxidising the tissues.

The Chairman proposed a vote of thanks to Professor Bell for his course of lectures, which was carried unanimously.

Proceedings of the Society.

CANTOR LECTURES.

ACETYLENE.

By Vivian B. Lewes,
Professor of Chemistry, Royal Naval College, Greenwich.

Lecture IV.—Delivered December 19, 1898,

As I have before stated it was in the autumn of 1894 that I first received a supply of American carbide, and in reporting on this material on November 26th of that year I wrote:—

"This gas when mixed with an equal quantity of air can be burnt at a No. 4 Bray burner, and the illuminating power of the mixture would be equal to 65·7 candles per five cubic feet of gas consumed, which would give the acetylene an illuminating value of 131·4 candles per five cubic feet. The presence of an inert gas such as the nitrogen in the air is well known to exercise such a cooling power on the flame as to seriously reduce its illuminating value, and I find that if the acetylene be burnt by itself at a suitable burner, it develops no less than 230 candle-power per five cubic feet of gas consumed."

Further experiments made during December, 1894, with carefully purified gas, yielded a slightly higher result, and in the paper read before this Society in January, 1895, I gave the illuminating power of the gas when burnt under the best conditions as being 240 candles.

A considerable amount of vagueness exists as to what is meant by the illuminating value of a gas, and the only assumption which can

be arrived at is that it is the highest illuminating effect which can be produced from the gas without the aid of regeneration or artificial air supply other than that created by the flame itself.

The proper combustion of any hydrocarbon gas, however rich, can be effected by supplying the flame with exactly the amount of air necessary to prevent smoking, and it is under these conditions that the highest illuminating effect possible with the particular burner is obtained.

With flat flames the ratio between the air supplied and the gas consumed is governed by two factors: — (*a*) The thickness of the flame; (*b*) The pressure under which the gas issues from the burner.

When a gas issues from a burner under pressure, the uprush of the escaping gas mechanically draws in air, so that when consuming a poor coal-gas in a flat flame the pressure has to be kept down, or too much air would be dragged in, which would consume the hydrocarbons too rapidly, and so seriously affect the amount of light emitted. As the gas increases in illuminating value, more and more air is required for proper combustion, and this can be obtained by increasing the pressure at the burner.

Experience has shown that with ordinary sized flat flame burners, seven-tenths of an inch in pressure gives practically the best results with coal-gas of the quality supplied in London, and up to a certain limit the same flat-flame burner can be used for richer gases by increasing the pressure. When this limit is reached, a thinner sheet of flame has to be employed, *i.e.*, a smaller burner used, low initial pressure resorted to, and then by increasing pressure this can be made to consume gases of increasing value, until the pressure reaches a point at which the flame becomes distorted, when a still smaller burner has to be taken. By such means as these even acetylene, with its enormously high illuminating value, can be satisfactorily consumed, whilst by thickening the flame and reducing the pressure to the point at which the uprush almost ceases to cause a mingling of air with the flame and leaves the supplying of the oxygen to diffusion, even a poor gas can be made to develop its illuminating power.

On consuming acetylene from a 000 union jet burner, at all ordinary pressures a smoky flame is obtained, but on increasing the pressure to four inches a magnificent flame results, free from smoke and developing an illuminating value of 240 candles per five cubic feet of gas consumed. Slightly higher values have been obtained, but 240 may be taken as the average value under these conditions.

This figure is the one quoted by most manufacturers of acetylene apparatus, who argue from it that acetylene is fifteen times as valuable in illuminating power volume for volume as London coal gas.

Such a comparison is, however, absolutely misleading, as in contrasting the value of acetylene with coal gas one must always bear in mind that the illuminating power of the London gas is determined by consuming it at the rate of 5 cubic feet per hour in the London argand, whilst in practice any power from 8 to 90 candles can be obtained from this volume, according to the form of burner in which it is consumed. Although small flat flame burners only emit from 1 to 2 candles per cubic feet of gas consumed, good incandescent mantles will yield about 18 candles per cubic foot, and certainly 17 on the average; and as incandescent gas lighting is rapidly displacing other methods of burning gas—and as this tendency will be enormously increased when the lapsing of the Welsbach monopoly reduces the price of the mantles to the figure now charged in Germany—it is evident that no calculation is fair that does not include this as a factor.

Moreover, a very short experience soon shows that burners consuming 1 cubic foot of acetylene per hour are the largest that can be practically used for domestic purposes, and that taking such burners all round 32 candles per cubic foot is a fair average of the light developed by them, although out of a big batch of burners you occasionally find a few which will go as high as 36 or even 40 candles per foot. The influence which the size of the burner and the rate of consumption has upon the illuminating power of coal gas is well known, and is shown in the following Table: —

Flat flame Burner.	Candles per cubic foot.
No. 7	2·44
,, 6	2·15
,, 5	1·87
,, 4	1·74
,, 3	1·63
,, 2	1·22
,, 1	0·85
,, 0	0·59

And as the consumption of acetylene is regu-

lated by exactly the same factors as act in the case of coal gas, it is evident that the smaller the burner and consumption, the lower will be the candle-power per foot of acetylene, and in practice with a one-half cubic foot burner 24 candles per cubic foot is a good result.

Taking a series of burners of the Naphey type, obtained from Falk Stadlmann and Co., the following results were obtained:—

No. of burner.	Pressure.	Gas consumed.	Light.	Candles per foot.
	inches.	cubic feet	candles.	
6	2·0	·155	0·7938	5·3
8	2·0	·27	3·2	11·6
15	2·0	·40	8·0	20·0
25	2·0	·65	17·0	26·6
30	2·0	·70	23·0	32·85
40	2·0	1·00	34·0	34·0

From these considerations it is evident that the only fair way to contrast the light obtainable from coal gas and from acetylene is to take the incandescent burner on the one hand and the 1 cubic foot flat flame on the other, when it is seen that instead of being fifteen times the value of the coal gas as an illuminant, it is only about twice its power. The acetylene burner, however, has one advantage over the mantle, and that is that you can more or less regulate the light to the amount you require.

When acetylene is burnt in air under such conditions as to complete its combustion, it is converted into carbon dioxide and water vapour, the same compounds as are produced by all combustible hydrocarbons.

$$2\,C_2H_2 + 5\,O_2 = 4\,CO_2 + 2\,H_2O$$

and 1 cubic foot of acetylene requires $2\frac{1}{2}$ cubic feet of oxygen.

The researches of Dr. Grehant have shown us that when burning with a smokeless flame no carbon monoxide can be detected in the products emitted by its combustion, and its sanitary position will therefore be defined by the amount of oxygen abstracted from the air and carbon dioxide produced as compared with other illuminants.

Taking the average-sized room, which would be well lighted by an illumination equal to 64 standard candles, we find that this amount of light from various illuminants would have the following effect on the atmosphere:—

Illuminant.	Oxygen removed from air.	Products of combustion.	
		Water vapour.	Carbon dioxide.
	cub. ft.	cub. ft.	cub. ft.
Sperm candles	38·5	26·2	43·6
Paraffin oil	24·9	14·0	39·8
London gas—Batswing	26·1	29·4	19·2
Argand	23·0	25·6	17·0
Regenerative	10·6	8·3	5·2
Incandescent	3·1	4·6	1·8
Acetylene	5·0	2·0	4·0

So that light for light it fouls the air less than any of our ordinary illuminants with the exception of the incandescent gas burner.

In comparing the heating effect of various illuminants on the air of a room, it is necessary to determine the calorific value of the combustion of a cubic foot of the illuminating gas employed, and it is manifest from theoretical considerations that a highly endothermic compound like acetylene must have a far higher heating power than ordinary coal gas. The mean of a number of experiments made in Junker's calorimeter gave as the thermal value of the ordinary London gas supply 158 calories, whilst under the same conditions acetylene yielded 320.

The theoretical amount of heat emitted by the combustion of a cubic foot of acetylene is 349·08 calories, but this would only be given by the absolutely pure and dried gas, and the experimental number determined in the calorimeter represents more truly the heating power of the moist gas under ordinary existing conditions.

Taking now the case in which a room is lit up with a power equal to 64 candles, we find that if we call the heating effect produced by an incandescent mantle giving this amount of illumination 100, then—

Ratio of heat emitted to yield a light of 64 candles.

Incandescent mantle	100
Acetylene	115
London Argands	571
Flat-flame burners	914

so that for all practical purposes the heating effect on the air by acetylene illumination is the same as with mantles.

When one comes to compare the cost of acetylene and coal gas, one is again struck with admiration at the statements made by the advocates of the former as a rival to the well established coal gas industry. At the present time the wholesale price of carbide is £20 a

ton, but I believe that to fill large cash orders it can be obtained at £16 at Foyers, which would mean at least £20 a ton at the works where it is to be decomposed and the gas distributed. The decomposition of carbide is not a costly operation, but at least 10 per cent. would have to be added to the price of the carbide for handling, water, repairs, interest on plant, purification, &c., and this would bring the price of the acetylene to £2 per 1,000 in the holder. Coal gas in the holder when made on the scale common in our big cities costs, however, about 1s. 2d. per 1000 in the holder, and about 100 per cent. has to be added to this to cover charges of distribution and profit. The power of doing this is dependent on the amount of gas sold, and whilst the South Metropolitan can make a fair profit on gas at 2s. 3d. a 1,000, there are many small country works that cannot pay a dividend with gas at three times the price. With acetylene the smallness of the output would necessitate a heavy charge over cost price, and I should be surprised to find an installation of acetylene even in a fair sized town paying its way with a less charge than £3 per 1,000.

Looked at from this point of view it is at once manifest how absurd it is to talk of acetylene as a possible rival of coal gas, and the sooner this is realised the better will it be for the future of this brilliant illuminant.

Abroad, where coal gas is dear, it is possible, by taking the price of acetylene in the holder and comparing it with distributed coal gas, to make acetylene out to be, light for light, as cheap as the latter when consumed in a flat-flame burner; but even this method of calculation breaks down before the high light emissivity of the incandescent mantle.

It is in those districts where no coal gas exists that the true field for acetylene is to be found, and here its ease of generation and the beauty of its light makes it a pleasant companion after the greasy dimness of the candle or the smell of the oil lamp.

When I first attempted to burn acetylene I used the Bray nipples, which could be had on the market, and found that I obtained very high illuminating effects, and could, for a time, continue the combustion in a satisfactory way by using three or four inches pressure at the burner. This high pressure was, however, undesirable, and I then devised a cubic foot burner in which, by drilling the union jet holes of very small size and at a more obtuse angle, I was able to burn the gas at an inch pressure. About this period, also, Bray made specially small tips for use with acetylene, and both these nipples answered extremely well for a time and developed from 30 to 36 candles per cubic foot of gas, but they both had the same weakness, and after a few hundred hours began to smoke, and as a smoking acetylene flame covers everything in a room with a thick deposit of soot in a very short space of time, such burners were manifestly not fitted for the work they had to perform.

The trouble generally commenced with a filiform growth of carbon appearing at the nipple, which quickly distorted the flame and caused a cloud of soot flakes to descend. If the burner was cleaned and relighted the trouble commenced again in an hour or two, and the only thing to be done was to replace the nipple by a new one.

If the nipple had been burning some time and was then removed and broken, it was found to be carbonised for some depth into the material, showing that a liquid hydrocarbon had soaked into the material and had been split up there by the heat with deposition of carbon.

The generally accepted idea was that the heat of the nipple polymerised some acetylene to benzene, and this, forming a drop, did the mischief, and efforts to keep the burner cool were looked upon as a likely direction in which to search for success.

Whilst these troubles were going on in England, attempts had been made in America to use acetylene diluted with a certain proportion of air, which permitted it to be burnt in ordinary flat-flame nipples, but the danger of such admixture being recognised, nipples of the same class as those used in England were employed, and the same troubles ensued.

In France single jets made of glass were first employed, and then Risener Luchaire, Ragot, and others, made burners in which two jets of acetylene coming from two tubes, spaced some little distance apart, should impinge and splay each other out into a butterfly flame. Soon after Bullier introduced the idea of sucking air into the flame at or just below the burner tip, and at this juncture the Naphey or Dolan burner was introduced in America, the principle employed being to use two small and widely separated jets instead of the two openings of the union jet burner, and to make each jet a minute bunsen in which each jet of acetylene dragged in from the base of the nipple enough air to surround and protect it whilst burning from contact with the steatite.

These burners were hailed with delight, and their success led to their being pirated right and left, but although these burners mark a very great improvement and will burn several hundred hours without smoking (unless in a fit of false economy the user insists on turning them down, and leaving them for an hour or so as two small separate flames, in which case they generally start smoking on being again turned on), the trouble is by no means got over, and a Naphey burner will often be found smoking as heartily as one of its more humble brethren.

The fact is that the cause of smoking is to be found quite as much in the generator as in the nipple, and over-heating during generation is undoubtedly a prime factor in this worrying phenomenon.

If smoke or tar vapour be examined under a high microscopic power it is seen that it consists of minute vesicles or bubbles in a most marvellously active condition of movement, and fulfilling in a most perfect manner the conception one forms of molecular motion. Ever bombarding each other but never colliding, these small vesicles filled with gaseous matter continue their career until some mechanical action bursts them, and deposits the minute trace of liquid which formed the skin of the microscopic balloon.

It is for this reason that the most successful form of washer for extracting tar during the manufacture of gas consists of fine jets or orifices through which the gas passes at considerable velocity, afterwards coming in contact with a baffle which breaks up the vesicles; and anyone with experience in carburetted water-gas making knows the trouble that arises from filiform growths of carbon, when, owing to an insufficient temperature in the cracking and superheating chambers, the carburetted gas contains vapours instead of permanent gaseous products.

When acetylene has been made in a generator at an undue temperature, it carries with it benzene vapour, which as it commences to condense assumes this vesicular form, and on coming to the extremely minute holes which form the apertures of the burner, the mechanical scrubbing which it encounters causes the breaking up of the vesicles and the deposition of the benzene and other hydrocarbons held in suspension by benzene, which soak into the steatite and carbonise. The presence of finely-divided carbon has a great effect in determining the decomposition of the acetylene itself, so that a rapid growth of carbon takes place at the burner, and no ordinary clearing of the deposited carbon from the exterior will ever make the nipple fit for constant use again, as the catalytic action of the carbon deposited in the pores of the steatite, and which cannot be got rid of, causes the deposition of a fresh supply of carbon; whilst, when the benzene vapour gets past the nipple and burns, as it requires three times as much air as acetylene, it often starts the flame smoking from this cause.

The impurities, however, in acetylene other than vapours also play a certain part in the choking of the burner, as if there be much phosphuretted hydrogen in the gas a small quantity of phosphoric acid is apt to be deposited in the burner nipple and helps to distort the aperture, whilst silica from siliciuretted hydrogen has the same effect.

It will be found with experience that the prevention of smoking in a burner will be overcome quite as much by attention to the temperature in the generator as to the burner itself, and where a generator which gives over-heating is in use, a well-arranged scrubbing apparatus that would get rid of the benzene from the gas would be found a distinct advantage in stopping burner troubles, while, when proper purification is introduced, the burner troubles will be found to have been practically solved.

At the Acetylene Exhibition, held in Berlin early this year, all the newest forms of burner were shown; the best burners of each class were tested at the Imperial Physical Institute for consumption and light-giving power, and it was found after eighteen hours' burning that several had to be eliminated on account of their commencing to smoke. Thirty hours proved fatal to another batch, while a few only continued giving satisfactory results after that period, a result which shows that the same troubles which have been rife in England have been equally marked on the continent.

The results also obtained as to the candle-power of these burners fully bear out the figures which I have obtained. It may be of interest at this point to record the candle-power of some of the many burners which I have personally tested—(see Table, p. 146)—and these really represent the best results obtainable by the combustion of acetylene under domestic conditions.

The Dolan or Naphey tip was a great advance at the time when it was introduced, but the arms which carried the tips were made

Date.	Name of Burner.	Pressure.	Gas consumed	Light.	Candles.	
					per ft.	per 5 c ft
1894	Lewes......	1·75	1·02	32·82	32·17	160·8
	Bray........	2·0	1·85	64·0	34·59	172·9
1895	Acetylene 4.	1·5	0·5	12·0	24·0	120·0
1896	Naphey or Dolan	2·0	0·6	16·0	26·6	133·0
1897	Falk Naphey	2·5	0·5	11	22	110·0
	,, ,,	2·5	0·75	20	26	130·0
1898	,, ,,	2 5	1·0	34	34	170·0
	Nurnberg ..	2·5	1·0	36	36	180·0
	Hera	2·5	0·8	26	32·5	162·5
	Ideal	2·5	0·75	20	26·5	132·5
	Bilwiller....	3·0	1·0	40	40	200·0

of metal, and this was perpetuated in the first batch of piracies made. The effect of heat after a time is to slightly distort these arms, thus throwing the two jets of gas a little out of line. This trouble has now been got over by making the arms of the burner entirely in steatite, which, although adding to the cost, is a distinct advantage.

The incandescent mantle has made such a revolution in coal-gas lighting that it is not surprising that attempts should have been made to adapt acetylene for this purpose, and the first thing which had to be done when taking steps in this direction was to construct an atmospheric burner which would satisfactorily consume the gas.

One would expect that acetylene when consumed in an atmospheric burner would give an excessively hot flame not only on account of its composition, but also on account of its endothermic character. Le Chatelier calculates that the temperature of a non-luminous acetylene flame will range from 2,100 to 2,420°C, the temperature varying with the ratio of acetylene to air as shown in the following calculations :—

Per-centage of Acetylene.	Per-centage of Air.	Temperature. °C.
7·4	92·6	2,420
12·9	87·1	2,260
17·37	82·63	2,100

In order to make a bunsen burner for acetylene, the tube has to be extremely narrow, and it is even then found to be very liable to flash back, whilst it needs a high pressure in order to bring about satisfactory combustion of the gas with an absolutely non-luminous flame. One of the chief difficulties which has to be overcome is due to the range over which mixtures of air and acetylene are explosive. This we have seen lies between the limits of 3 per cent. and 82 per cent. of acetylene and it must also be remembered that the velocity of the explosion of acetylene when mixed with air is greater than with a mixture of air and coal gas, and the propagation of the explosive wave down the burner tube cannot be satisfactorily stopped by the ordinary device of using wire gauze on account of the low igniting point of acetylene and air mixtures. If high pressures are used so that the rate of flow shall be greater than the velocity of propagation downwards, more air is sucked in by the uprush of the gas and the velocity of the explosion is again increased.

The best results have been obtained by taking a bunsen burner in which a constriction in the air-tube creates a high velocity at that point which on the principle of the Smithell's flame separator prevents the propagation downwards just at that point.

Le Chatelier has shown that the rate of propagation of an explosive mixture of air and acetylene depends upon the diameter of the tube through which the wave is being propagated, and he has worked out the limits between which the explosive wave would pass through tubes of certain diameters.

Diameter of Tube. Inches.	Explosion. Lower Limit. Per cent. Acetylene.	Explosion. Upper Limit. Per cent. Acetylene.
1·57	2·9	64
1·18	3·1	62
0·79	3·5	55
0·24	4·0	40
0·16	4·5	25
0·08	5·0	15
0·03	7·7	10
0·02	0·0	0

It will be seen that in a tube 0·02 inches, or 5 mm. in diameter you have the propagation of the explosive wave ceasing.

These investigations have been used as a basis upon which to construct acetylene burners for heating purposes, and burners have been made by the Allgemeine Carbid and Acetylengas Company of Berlin, in which, by means of constricted tubes satisfactory consumption is ensured. It is found that the diameter of the tube at the constriction must be in a definite proportion to the particular mixture of air and acetylene consumed, as the more air employed the greater must be the constriction in the strangulated portion of the tube. Such

rners have a flame which is very valuable heating purposes, and gives a very intense nperature.

The same company has also used these rners with incandescent mantles of somewhat ferent shape and composition to those linarily employed, and states that the photo-tric result is 30 to 40 per cent. higher than at obtained by the combustion of pure etylene alone. I have lately been experi-nting with an acetylene bunsen and get ich higher results than these. With a Wels-ch No. 2 mantle I have obtained as much 90 candles per cubic foot of acetylene con-med, and as far as I have gone the mantle pears to be hardened and strengthened the intense heat to which it is subjected, t it yet remains to be seen how the life of the ntle is affected by the temperature of the me.

Acetylene atmospheric burners are now also ployed for heating, cooking, and metallur-al operations on a small scale, and with a luction in the price of the gas these uses for will undoubtedly open up a wide field of lity.

The value of acetylene in photographic work iow universally recognised, and Mr. W. H. lmsley has determined its relative value as npared with the ordinary sources of light, determining the time needed to fully expose efully prepared plates, with the following ults:—

	Seconds.
Direct sunlight	1
Acetylene 1 cubic foot burner	3
Diffused daylight reflected from mirror	12
Incandescent mantle	24
Coal gas / Oil gas / Oil lamp	240

t is also to a certain extent used for pro-ion work, but it is not so well suited for , as in common with multiple wick oil ps and incandescent mantles, the flame rs too large a surface of illumination.

I. Molteni has attempted to determine the jection value of various illuminants by a tometric process in the following way:—

he measurements were made with an inary lantern, the stage of which carried an que card in which was cut an aperture cm. square, and the distance of the lantern n the screen was such that each side of the are on the screen measured 1 metre.

he screen was replaced by a disc of paper, the opposite side being illuminated by a standard lamp burning 42 grams of oil per hour. The distance of this lamp was varied in order that equality of illumination might be obtained on the screen, and the photometric values of the light were determined from the distance of this lamp.

Multiplewick lamp	1·00
Incandescent gas No. 2 burner no reflector	1·00
Acetylene 1 burner no reflector	1·06
,, 2 ,, ,,	1·70
,, 3 ,, ,,	3·20
,, 4 ,, ,,	4·10
,, 5 ,, ,,	4·50
Limelight, alcohol and oxygen	5·80
,, oxyhydrogen	16·60
,, etho-oxygen	18·50
Electric incandescent 32 candle-power	0·68
Electric incandescent 50 candle-power vertical	0·93
Electric incandescent 50 candle-power horizontal	0·93
Electric focus 100 candle-power	3·82
,, arc lamp 7 amperes	39·03
,, ,, 10 ,,	75·61
,, ,, 12 ,,	86·50
,, ,, 15 ,,	117·61
,, ,, 20 ,,	160·80

Carbide will probably some day become an important factor in the transmission of power, as a cubic foot of solid carbide would weigh 62·26 kilos or 137 lbs., and if of commercial purity would yield 685 cubic feet of acetylene having a thermal value of nearly 232,215 calories.

In practice, however, the weight of carbide which can be got into a cubic foot space is dependent on the size to which the material is broken, and with the ordinary commercial carbide a fair average would be 80 lbs. per cubic foot, yielding 400 cubic feet of acetylene gas, with a thermal value of 139,600 calories. It is at once manifest that solid carbide is as economical a method of transporting acety-lene as if liquid acetylene itself were employed, as the liquid will only yield about 400 times its own volume of gas, and the carbide has the advantage of being practically safe in transit.

There are several people at present working on the utilisation of acetylene for gas motors, but there are many difficulties to be overcome before this is successfully accomplished, as the deposition of carbon when the air supply is in-sufficient, and the violence of the explosion are troublesome factors to deal with.

The trouble of completely consuming acety-lene without smoking in the early days of its inception caused Dickerson and Suckert to

attempt the combustion of acetylene diluted with air. In 1894 it was in this way that the gas was consumed, but not only did the cooling action of the nitrogen lead to a considerable decrease in the illuminating power of the acetylene so diluted, but as will have been seen from the experiments of Gerdes and others a very serious risk was incurred, it becoming merely a question of the breadth of the delivery tubes and the rate of flow of the gas whether an explosive wave was propagated back to the mixing machine or not. It was on account of the danger of this that this process of burning it in America was abandoned.

The idea has, however, cropped up from time to time since, and both in France and Holland has been, to a certain extent, used on a practical scale. Even at the present time an attempt is being made in Manchester to introduce a process by which acetylene can be so diluted with air as to burn in an ordinary Bray burner.

The danger of diluting acetylene with air being so manifest, attempts have, from time to time, been made to dilute it with other gaseous material. In 1895 Bullier took out a patent for improvements in carburetting air and gas, in which he claims the use of acetylene for enriching water gas, whilst having then apparently found that acetylene was useless for this purpose, he, later on in the same year, took out a second patent for diluting it with nitrogen. It was about this time, also, that Mr. Gerdes commenced his experiments upon the enrichment of oil gas with acetylene, which have borne such ample fruit on the Continent. He showed that when oil gas is enriched with 25 per cent. of acetylene a valuable increase in its illuminating power is obtained without any danger of explosion of the mixture owing to heat or shock. This mixture is now employed to a very large extent on the Prussian railways; the quantity of carbide already used this year for this purpose has reached a total of 3,000 tons, and it is computed that before the end of next year 10,000 tons per annum will be needed for this purpose.

In consequence of the great Continental success of this admixture application was lodged at the Home Office to sanction such a mixture in England under the ordinary railway carriage cylinder pressure of 10 atmospheres. The safety of the mixture and of mixtures considerably richer in acetylene was completely established by a series of tests carried out in the presence of the Home Office officials, and in consequence, by an order of the Secretary of State, dated March 28, 1898, a mixture of oil gas with 20 per cent. of acetylene is allowed to be used at a pressure not exceeding 150 lbs on the square inch.

In order to determine the increase in illuminating power given by various per-centages of acetylene in oil gas, and whether the mixture could be employed with economy, the following experiments were instituted. Oil gas containing 20 per cent. of acetylene was compressed into a cylinder under a pressure of ten atmospheres, some of the original oil gas being also compressed in a second cylinder to the same pressure. Both cylinders were then blown off to 5·8 atmospheres, and the illuminating power of each was taken under identical conditions. The burner used was a "40 litre" one, and the results were as follows:—

Pressure.	Gas Consumption.	Illuminating Value. Oil Gas.	Oil Gas and Acetyle[ne]
5·8	1 cubic foot	7·4	15·6

An analysis of the gas showed that the mixture contained 22 per cent. of acetylene, although but 20 per cent. was originally added, the increase being due to the loss of some of the oil gas in which under pressure some of the vapours of benzene and toluene condense to the liquid state. Working from these figures it will be seen that the addition of 22 per cent. of acetylene caused an increase of illuminating power of 110 per cent., or 100 per cent. with 20 per cent. of acetylene.

The original oil gas and the mixture of oil gas with acetylene were next determined photometrically in an ordinary railway carriage lamp at angles below the horizontal on the Diodin radial photometer.

Oil Gas.

Angle.	Pressure.	Gas.	Candles.	Candles per foot
Horizontal	1·0	2·0	7·4	3·7
10	..	..	8·0	4·0
20	..	..	8·2	4·0
30	..	..	8·2	4·1
40	..	..	8·2	4·1
50	..	..	8·0	4·0
60	..	..	7·6	3·8
70	..	..	7·8	3·9
80	..	..	8·0	4·0

Average candles per cubic foot .... 3·9

Oil Gas and Acetylene.

Angle.	Pressure.	Gas.	Candles.	Candles per foot.
rizontal.	1·0	2·0	17·0	8·5
10	..	..	17·0	8·5
20	..	..	17·5	8·75
30	..	..	18·0	9·0
40	..	..	17·0	8·5
50	..	..	17·0	8·5
60	..	..	17·0	8·5
70	..	..	16·5	8·25
80	..	..	16·5	8·25

Average candles per cubic feet 8·5.

wing that the addition of 20 per cent. of tylene increases the illuminating power of oil gas by over 110 per cent. at all angles. hese figures show therefore that the ad- on of the 20 per cent. of acetylene doubles illuminating value of the oil gas.

Vith regard to cost, as we have before seen, ylene at the present price of carbide will about £1 18s. to £2 per 1,000 in the ler, and 200 cubic feet will accordingly 7s. 8d. The compressed oil gas costs 6s. to 12s. per 1,000. With oil gas at 8s. 1,000, 800 cubic feet will cost 6s. 5d., so that otal cost of 1,000 cubic feet of the enriched will be 14s. 1d., but as the illuminating e of the mixture is double that of the plain gas, there is an economy of 1s. 11d. per o. As the oil gas is dearer the saving will reater, and *vice versa*, so that with cheap oil the addition of acetylene would not pay. h oil gas at 6s. 6d. per 1,000 there is practi- y no difference, but the advantages accruing the use of acetylene would make the ure more desirable than the plain gas. ngst the advantages are these—that the ders would last for double the length of they would with the oil gas having the one ge, and there would be not so much ation of liquid hydrocarbons due to com- sion with consequent revapourising when pressure is reduced, thus causing inequality e illuminating power.

he whole question of diluting acetylene other gases has had a very great interest ne, and I have made many experiments in r to determine how it is that when 10 per of acetylene is added to a diluent such lue water gas, carbon monoxide, or even ogen, the resulting mixture is practically luminous, and I have worked out the enrichment value for acetylene for all those gases which might be employed for its dilution.

I soon discovered from these experiments that methane is the only diluent which sustains the illuminating power of the acetylene when mixed with it in small proportions, and the fact that the same phenomenon is observable in comparing the illuminating power of mixtures of gases containing only some 30 per cent. of methane gives at once a clue to the methods which must be adopted in making a diluting gas for acetylene.

It is perfectly obvious that in many places it would be a great advantage to have an illuminating gas of about 20 candle-power for general distribution in the same way as a good coal gas could be used, if such a mixture could be produced at a price comparing favourably with coal gas under the same conditions. In order to do this, although it would be impossible to use pure methane as the diluent for acetylene on account of the cost of its production, it is quite easy to make diluting gas which shall contain 30 per cent. of methane at a comparatively low rate.

In order to make this, a slightly modified form of water gas generator is employed, and the fuel having been blown up to incandescence by an air blast, tar, creosote oil, heavy oil residues, or practically any waste liquid hydrocarbon is injected into the body of incandescent fuel by a steam injector or atomiser. If these hydrocarbons were allowed to run into the fuel by themselves, they would simply be burnt up to carbon and hydrogen, but steam being injected with them, the steam is decomposed by the fuel with the formation of water gas which to a certain extent envelops the hydrocarbon, and instead of its undergoing complete decomposition it is broken down to methane and hydrogen and mingles with the water gas, whilst any residual carbon is left behind in the fuel. It is quite possible by such means to make a diluting gas containing—

Hydrogen..................	45
Carbon monoxide	15
Methane	30
Unsaturated hydrocarbons....	5
Carbon dioxide and nitrogen..	5
	100

This gas costs from 8d. to 10d. per 1,000 cubic feet, and has an initial illuminating value of about 10 to 12 candles, and on mixing with it 5 per cent. of acetylene, a gas having an illuminative value of 18 to 20 candles is obtained, which being a mixture of perfect

gases gives no trouble as regards layering, and which having the same specific gravity and illuminating value as coal gas, can be distributed and burnt in precisely the same way.

It is also found that mixtures of this gas with 50 per cent. of acetylene are not detonated when compressed for railway carriage lighting by any temperature which it would be possible to attain in the cylinder, and it seems that this method of utilising acetylene is pre-eminently the one which promises for it the largest and most remunerative future.

In concluding this course of lectures, I am oppressed by the feeling that the limited time at my disposal has prevented me from doing full justice to my subject; and I should have far preferred a course of forty rather than four lectures in order to deal with the many important points and side issues which of necessity have been omitted. I leave my subject with the sincere hope that as time wears on those points which appear to us now to be difficulties will be made clear, and that in the future cheapened carbide will enable this beautiful hydrocarbon to take its proper place in the foremost ranks of our illuminants.

Miscellaneous.

CULTIVATION OF FILBERTS IN ITALY.

Filbert plantations exist on a large scale near Piazza, Armerina, and Aidone, in the province of Caltanissetta, and Palagonia, province of Syracuse, at an elevation of from 1,968 to 2,625 feet above the sea. They are also cultivated in large quantities in the regions of Etna, in the valleys between Linguaglossa and Cartigleone, Randazzo and Bronte. In these localities the filberts are the rivals of the grapes in commercial importance. The plants, which are made to grow as bushes, forming groups, consisting of about ten shrubs, well cultivated, thrive in deep fresh ground tending to clay, possibly irrigated when not endowed with natural freshness. A position not exposed to cold winds is preferred. According to the United States Consul at Catania, the land selected for the culture of filberts may be broken up partially or entirely, according to the means at disposal. After having laid out the ground and marked off the places where the bushes are to stand, the groups 16 to 25 feet apart (when too close together they are deprived of air and light, and the production is restricted), a circle of about four feet is marked around the stake and dug out to the depth of 16 inches around the circumference, gradually inclining towards the centre where the hard ground is reached. About eight inches apart, within this periphery, [illegible] to ten slips of some 32 inches in length are pl[illegible] so as to leave about two or three buds abov[illegible] earth. The hole is now refilled with fine [illegible] stratified with fermented stable manure. A n[illegible] of suckers will sprout from some slips, other[illegible] yield none. The proper season for planting is [illegible] the first rainfall, from November to December. [illegible] sprigs for reproduction are derived from the m[illegible] bushes. Filberts can be produced from the [illegible] but this is never done, because the plant pro[illegible] from seed not only would require much more ti[illegible] bear fruit, but would naturally grow wild, and [illegible] wards would have to be grafted, and therefor[illegible] suckers (shoots or sprouts) are preferred. Ce[illegible] barley, rye, or wheat are sown in the filbert [illegible] tations during the first years; afterwards veget[illegible] are cultivated therein. The first manuring is [illegible] as already stated, when the sprigs are planted; [illegible] wards every three years. The annual culti[illegible] consists of a thorough digging in January, [illegible] around the roots, and a second superficial o[illegible] July. The purpose of the superficial diggir[illegible] essentially to clean the soil of the weeds, which, [illegible] chopped down, work into the soil, and help to [illegible] the moisture. During this operation care shou[illegible] taken not to destroy the cavities. During the [illegible] two or three years the plant does not bear fruit [illegible] commences the third year. Any blossoms appe[illegible] before this time shonld be removed, otherwise [illegible] young brush would suffer. According to the se[illegible] the roots should be bared and recovered. The pr[illegible] is done when the leaves are falling, and consis[illegible] cutting the offshoots, sprigs which are too long [illegible] the old and dried branches; the latter are replace[illegible] young sprouts, and in this manner the planta[illegible] can be revived indefinitely; in fact, there are [illegible] tations 50 to 100 years old. Irrigation takes [illegible] from June to August, once a week. Gathering [illegible] is from the end of August to the middle of Se[illegible] ber, according to the season. The filberts are [illegible] suhject to serious diseases, but hail storms and [illegible] winds cause the greatest damage.

DESTRUCTION OF LOCUSTS IN ARGENTINA.

The central commission for the extinction o[illegible] *langosta* or locusts in Argentina has made a [illegible] interesting report to the Minister of Agricultu[illegible] that country. The commission was appointed fo[illegible] purpose of obtaining all the information pos[illegible] regarding the locust, its habitat, procreation, m[illegible] tion, &c., and to inaugurate concerted efforts f[illegible] extinction. To this end the commission orga[illegible] many local commissioners, and these again fo[illegible] a sub-commission, and all investigated and ado[illegible] such means of destruction as seemed most effec[illegible] The results are that the habits of the locust have [illegible]

studied, enormous quantities of eggs and *saltonas* [...]sts before they have wings) were destroyed, and destruction of crops greatly lessened. The [...]s of extinction employed were, a preparation of various liquid extirpators, the plough and fire. quantities thus destroyed in 1898 are estimated [...]ousands of tons weight, and the area of crops [...]d at hundreds of thousands of acres; and it is [...]ved that if, with what has been learned, those [...]nised efforts be assiduously continued, the locust be controlled, or its ravages greatly restricted. arrest of the ravages of the locust, whether [...]ugh the efforts mentioned or other causes, has [...]tly encouraged the agriculturists of Argentina, improved the general condition of the country.

FLAX RETTING IN FRANCE.

[...]any attempts have been made in France in past [...]s to substitute for the antiquated process of [...]ng flax in the river a more practical process. United States Commercial Agent at Roubaix that a few years ago Messieurs Doumer and R. de [Swa]rte invented a process of steeping in closed vessels, [whic]h has been thoroughly tested by a commission [appo]inted at Lille by the Minister of Agriculture. report of the president of this commission states the value of the process has been tested by direct [expe]riments. It consists in immersing flax in closed [vesse]ls, with the addition of certain microbes. The [tem]perature, gauged so as to prolong the vitality [of t]he microbe to the greatest possible extent, is [...]ly maintained. Under these favourable con[ditio]ns the retting is reduced to the shortest possible for each species of flax. As soon as the flax is [...]ed, the vessels are drained. The drying process [is a]ccomplished without disturbing the flax, by [mea]ns of hot air introduced by a ventilator. This [oper]ation requires but little time, and the drying is [unif]orm. After having ascertained that the new [proc]ess accomplishes retting in the most thorough [man]ner, the sub-commission proceeded to study the [...]ing and bleaching of flax retted and dried by this [proc]ess, and published as its opinion that this process, [ad]opted in the different flax-producing countries, [woul]d give a far superior retting to that practised on [f]arms. Flax retted as at present has less value [tha]n if it had been subjected to a proper process, and [conse]quently occasions loss to the farmer. The first [...] were made with a vessel containing only 40 kilo[gra]mmes (88 lbs.) of raw flax. Since then Messieurs [Dou]mer and de Swarte have opened a factory at [...]becque, department of the Nord. In a recent [suppl]ementary report the president of the commission [state]s that the retting and drying is as well accom[plish]ed in a vessel containing 2,000 kilogrommes [(4,40]0 lbs.) as in the small one; also that the system [is s]o arranged that any quantity desired can be [...]ed with the same satisfactory results. The importance of this process is commented upon in various French papers. Its adoption, in their opinion, will save the farmer the cost of transport of his flax to the Lys, as he can have the retting done as well, if not better, in a factory in his own vicinity, with the additional advantage that the cost will be less.

General Notes.

MAP OF LONDON.—The New Year's number of the *Builder* (Jan. 7) contains a large map of the County of London, showing the boundaries of the surveyors' districts under the Building Act, taken from the official map of the London County Council. The names and addresses of the district surveyors are added.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 18.—"Canals and Inland Navigation in the United Kingdom." By L. F. VERNON-HARCOURT, M.A. Sir E. LEADER WILLIAMS will preside.

JANUARY 25.—"Tuberculosis in Animals." By W. HUNTING. R. BRUDENELL CARTER, F.R.C.S., will preside.

FEBRUARY 1.—"The Cost of Municipal Enterprise." By DIXON H. DAVIES. The ATTORNEY-GENERAL will preside.

FEBRUARY 8.—"Leadless Glazes." By WILTON P. RIX.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

JANUARY 19.—"Railways in Burma and their Proposed Extension across Yunnan." By J. NISBET, D.Oec., Conservator of Forests, Burma. Sir ALEXANDER MACKENZIE, K.C.S.I., late Lieutenant-Governor of Bengal, will preside.

The meetings of January 19, February 9, and March 9, will be held at the Imperial Institute; those of April 13, May 11 and 25, at the Society of Arts.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 24.—"Rhodesia and its Mines in 1898." By WILLIAM FISCHER WILKINSON, F.G.S., Assoc. M.Inst.C.E. The Hon. Sir DAVID TENNANT, K.C.M.G., Agent-General for Cape Colony, will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

JANUARY 31.—"The Centenary Exhibition of Lithographs, with remarks on further Developments of the Art." By EDWARD F. STRANGE.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

LECTURE I.—JANUARY 16.

Primitive methods—Earth disposal—Cesspools—Infiltration through soil—Water-carriage—Pollution of rivers and effects of dilution—Irrigation—Early results.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Samuel Rideal, "Bacterial Purification of Sewage." (Lecture I.)

United Service Institution, Whitehall, S.W., 3½ p.m. (Juvenile Lecture.) Colonel E. T. Browell, "General Gordon, the Mahdi, and the Reconquest of the Soudan."

Imperial Institute, South Kensington, 8½ p.m. Rev. Gilbert Reid, "Personal Experience in China."

Cleveland Institute of Engineers, Middlesborough, 7½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Award of Prizes and Studentships.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper on "Glacial Action in the Southern Hemisphere."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor A. K. Douglas, "The Future of British Trade in China."

TUESDAY, JAN. 17...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "The Morphology of the Mollusca." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. William G. Kirkaldy, "The Effects of Wear upon Steel Rails." 2. Sir William C. Roberts-Austen, "The Microphotography of Steel Rails."

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5 p.m. Sir Robert Giffen, "The Excess of Imports."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. (Photo mechanical Meeting.) Mr. J. E. Johnson, "Some New Half-tone Screens of English Manufacture."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Arthur Willey, "General Account of his Zoological Expedition to the South Sea." 2. Prof. D'Arcy W. Thompson, "The Characteristic Points in the Cranial Osteology of the Parrots." 3. Miss Isa L. Hiles, "Report on the Gorgonacean Corals collected by Mr. J. Stanley Gardiner at Funafuti."

Colonial Inst., Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Hon. Sir Horace Tozer, "Queensland's Progress."

WEDNESDAY, JAN. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. L. F. Vernon-Harcourt, "Canals and Inland Navigation in the United Kingdom."

Meteorological, 25, Great George-street, 7½ p.m. Annual General Meeting. Addre Mr. F. Campbell Bayard, "The Govern Meteorological Organisations in various pa the World."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 Annual General Meeting. Address by the dent.

Entomological, 11, Chandos-street, W., 8 Annual General Meeting.

Archæological Association, 32, Sackville-street 8 p.m.

THURSDAY, JAN. 19...SOCIETY OF ARTS (Indian Sec East Conference Hall, Imperial Institute, 4½ p.m. Mr. J. Nisbet, "Railways in Burma their Proposed Extension Across Yunnan."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. M R. Murray and Miss F. G. Whitting, "New diniaceæ from the Atlantic." 2. Mr. Arth Maslen, "The Structure of Lepidostrobus." Dr. W. G. Ridewood, "Some Observations c Caudal Diplospondyly of Sharks."

Chemical, Burlington-house, W., 8 p.m. 1. W. Ackroyd, "Researches on Moorland W (I. Acidity)." 2. Dr. F. S. Kipping and Mr. A Hill, "α-ketotetrahydronaphalene." 3. Mr. A. Bone, "A New Method for Preparing Dimethyl- and Trimethyl-succinic Acids." Messrs. Thomas Purdie and William Pithe "Reduction of Optically Active Mono- an alkyloxysuccinic Acids from Malic and Ta Acids." 5. Dr. Siegfried Ruhemann, "Act Ammonia on Ethereal Salts of Organic Ba 6. Dr. J. J. Sudborough and Mr. Lorenzo L (*a*) "Esterification Constants of Substituted A Acids;" (*b*) "Di-ortho Substituted Benzoic A Part IV.—Formation of Salts from Di-o substituted Benzoic Acids and different Or Bases." 7. Mr. J. Holmes Pollock, "The Th Effect of Dilution." 8. Mr. D. B. H. "The Changes of Volume due to Diluti Aqueous Solutions."

London Institution, Finsbury-circus, E.C., 6 Mr. A. F. Sieveking, "Gardens: their H and Literature."

Society for the Encouragement of Fine Arts, 9, duit-street, W., 8 p.m. Mr. J. S. She "Chopin—his Masurkas, Polonaises, and ludes." (With Musical Illustrations.)

Royal Institution, Albemarle-street, W., 3 Mr. A. H. Savage Landor, "Tibet an Tibetans." (Lecture I.)

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, JAN. 20...Royal Institution, Albemarle-street 8 p.m., Weekly Meeting. 9 p.m., Prof. D "Liquid Hydrogen."

Quekett Microscopical Club, 20, Hanover-s W.C., 8 p.m.

Physical, Chemical Society's Rooms, Burlin house, W., 5 p.m. 1. Mr. Edwin H. B "The Equivalent Resistance and Inductanc Wire to an Oscillatory Discharge." 2. M Appleyard, Exhibition of (*a*) a Dephegn (*b*) a Temperature Tell-tale. 3. Mr. Littlewood, "The Volume Changes accompa Solution."

SATURDAY, JAN. 20...Royal Institution, Albemarle-stree 3 p.m. Sir Alexander C. Mackenzie, "L with musical illustrations.

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FRIDAY, JANUARY 20, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 16th inst., Dr. SAMUEL RIDEAL delivered the first lecture of his course on "Bacterial Purification of Sewage."

The lectures will be printed in the *Journal* during the summer recess.

ALTERATION OF MEETING.

The attention of Members is called to the fact that an alteration will be made in the arrangements for the Wednesday evening meetings. The reading of the paper by Mr. WILTON P. RIX on "Leadless Glazes," announced for the 8th of February, will be postponed until the 1st of March, and on the 8th of February, a paper will be read by Mr. JAMES SWINBURNE on "Nernst's Electric Light."

Proceedings of the Society.

SIXTH ORDINARY MEETING.

Wednesday, January 18, 1899; Sir E. LEADER WILLIAMS in the chair.

The following candidates were proposed for election as members of the Society :—

Aflalo, Frederick G., Newark, Bournemouth.
Anning, Edward Herbert, 51, Bethune-road, Stamford-hill, N.
Birt, Sir William, Great Eastern Railway, Liverpool-street Station, E.C.
Campbell - Johnston, Ronald C., Nelson, British Columbia, and 86, York-street, Westminster, S.W.
Cotton, Ross, Cape Town and Surburban Electric Lighting Company, Rondebosch, Cape Colony.
Darby, John Henry, Pen-y-Garth, Brymbo, Wrexham.
Davis, William, Engineer's Department, Stock Exchange, E.C.
Grugeon, Charles, 49, Wickham-road, S.E.
Hartmann, George H. J. Newlands, Thames Ditton, Surrey.
Herman, Benjamin Richard, McLeod-road, Karachi, India.
Immisch, Otto Claude, 102, Tollington-park, N.
Kenward, James, 43, Streatham High-road, S.W.
Marsden, Miss Kate, 11, Redcliffe-gardens, S.W.
Mumford, Arthur George, Culver-street Ironworks, Colchester.
Nicholson, H. Godfrey, Bellevue, Montenotte, Cork.
Preston, Edward Stuart, M.A., 63, Drayton-gardens, South Kensington, S.W.
Regan, William Frederick, 41, Threadneedle-street, E.C.
Ridley, Henry N., M.A., Botanic-gardens, Singapore, Strait Settlements.
Steel, Charles, Great Northern Railway, King's-cross Station, N.
Stewart, George Lawrence, M.A., Queen Anne's-mansions, St. James's-park, S.W.
Stobie, Harry E., Grand Junction Railways, Cookhouse, South Africa.
Waterhouse, Colonel James, Oak-lodge, Eltham, Kent.
Webster, Arthur Harold, Brooklands, Riverhead, Kent.

The following candidates were balloted for and duly elected members of the Society :—

Granger, Arthur Otis, Girard-buildings, Philadelphia, U.S.A.
Johnson, Alexander Banks, Bringewood, Mulgrave-road, Sutton, Surrey.
Kitching, Henry, J.P., The Grange, Great Ayton, Yorkshire.
Lutwyche, Stanley, 3, Chichester-terrace, Brighton.
Stevens, Charles, 10, Wemyss-road, Blackheath, S.E.
Winch, Richard, Morden-grange, Kidbrook, Blackheath, S.E.

The paper read was—

INLAND NAVIGATION IN EUROPE AND NORTH AMERICA, WITH SPECIAL REFERENCE TO INLAND NAVIGATION IN ENGLAND.

BY LEVESON FRANCIS VERNON-HARCOURT, M.A., M.Inst.C.E.

Two extreme, and absolutely opposite opinions have been occasionally expressed with regard to inland navigation in England, namely, that since the introduction of railways the waterways of the country have become useless; and, on the other hand, that the canals should be purchased and improved by the Government for the public benefit.

The first view appears to derive a partial justification from the fact that as soon as the railways entered into competition with the canals, which had rendered such services to trade in England in the latter part of the last century and the early portion of the present century, the traffic on most of the canals greatly declined, some of the canals were eventually abandoned, and in a few instances canals were converted into railways. These results, however, and the present condition of inland navigation in England, must to some extent be attributed to the diversion of public interest and capital from canals to railways, leading to the neglect of improvements of the waterways to cope with the new competitor; the want of uniformity in dimensions of adjacent canals, and the divided ownership of through routes, in some of which important limbs fell into the hands of the competing railway, obstacles which fettered some of the main lines of railways in early days, but were overcome by the adoption of a uniform gauge and by amalgamation. The incorrectness of the general assumption that canals have become useless in Great Britain is readily proved by a reference to the Birmingham Canal Navigations, which, though under the control of the London and North-Western Railway, possess a yearly traffic of about 7,750,000 tons; whilst the Aire and Calder, and Weaver navigations, and the Grand Junction, Leeds and Liverpool, and Bridgewater canals as independent concerns, and the Trent and Mersey and Forth and Clyde navigations, and the Shropshire Union Canals, belonging to railway companies, have a yearly traffic of between 1,000,000 and 3,000,000 tons.

In support of the second opinion, the general practice in other countries might naturally be cited; for not only on the Continent of Europe, but also in Canada and the United States, the Government takes charge of the maintenance, improvement, and extension of most of the waterways. The State, moreover, reaps the indirect benefits which result from the expansion of trade and the increased prosperity of the community, by the improvement and cheapening of internal communications; whereas a company can only obtain the direct profits which may be derived from the undertaking. In a waterway, also, traversing a very long stretch of country, in which a variety of interests are concerned, the State possesses a greater unity of purpose, authority, control of large funds, and regard for the general good, than is likely to belong to any company. State purchase and control of the waterways is however, opposed to the system hitherto fol lowed in Great Britain, where private enter prise has been relied npon for the prosecutio of commercial undertakings, with remarkabl satisfactory results. Moreover, Great Britai possesses a very complete network of railways as well as roads; and as the extreme souther and northern counties of England, the wester portion of Wales, and a great part of Scotland are almost devoid of inland navigable water ways, the improvement of the existin canals and navigations could not be regarde as benefiting the whole community, except t the extent that it might facilitate and cheape the general distribution of goods and produc in the country. As the canals also have, fo the most part, been constructed in the mos favourable localities, the only economica method of extending better means of com munication than roads to localities where th traffic would necessarily be small, would be b almost surface lines of light railways an tramways, laid, where practicable, alongsid the existing roads.

The true solution of the problem of the bes way of dealing with inland navigation in Grea Britain, appears to lie somewhere between th extreme opinions quoted at the outset. Certai inland waterways in the country attract a larg traffic in bulky goods, in spite of the seve competition of railways, and are fulfilling, wit profit to their owners, the very important fun tion of providing the trader with an alternati route, and thereby keeping down the railwa rates with advantage to the public; whil some waterways are actually used by the rai ways themselves to relieve portions of the over-burdened lines of some of the bulky goo traffic, and thus enable them to defer t expense of widening their system. Wheth the insignificant traffic on many of the wate ways of Great Britain is to be mainly attribute to the variety in dimensions, the neglect improvements, and the divided ownership, to unfavourable conditions and lack of su able traffic, can be best determined after e amination of the inland navigation in oth countries, where greater interest has bee manifested in the development of the wate ways, and the State has provided funds f the improvements. The intervention of t British Government for the general improv ment of the waterways of the country, i volving the competition for traffic, by the he of public funds, with the vested interests the railway companies, could only be justifi

f it was proved that an adequate development f the waterways could not be effected by ther means, and that such a step would be great public benefit to the country at large.

Recent Interest Evinced in Inland Navi-ation.—Signs of an increasing public in-erest in inland navigation, as a means of urther promoting and cheapening the trans-ort of minerals and bulky merchandise in ngland, have been manifested from time to me of late years. Thus in 1872, a Joint ommittee of the two Houses of Parliament n Railway Amalgamation pointed out the ijury that had been done to the free com-etition of inland navigation with railways, y the purchase of important links by the ilways companies on the main lines of water ommunication, and urged that not only hould no inland navigation in the future be ermitted to pass under the control of a rail-ay company, but that the compulsory pur-hase of canals from railway companies should e favourably entertained by Parliament, and at the utmost facilities should be afforded for e amalgamation of adjacent lines of inland avigation.* In 1883, a Select Committee of e House of Commons was "appointed to quire into the condition and the position of e canals and internal navigation of the untry, to report thereon, and to make such commendations as may appear necessary." considerable amount of evidence was given fore this committee on the existing condition inland navigation in the United Kingdom, ich was published the same year in a ue-book †; but as the recommendation of e committee, that it should be re-appointed the following Session, was not acted upon, report was ever made by the committee. In 88, a Canal Conference was held at the ciety of Arts, extending over two days, at ich several papers relating to inland naviga-n were read and discussed; and a full report the proceedings of the Conference was sub-quently published in the *Journal* of the ciety,‡ and also in the form of a pamphlet, companied by a small map showing the nals and navigable rivers of England and ales. The Railway and Canal Traffic Act 1888 was passed in the same year; and under the provisions of this Act a Blue-book was issued by the Board of Trade in 1890, giving the returns in respect of the canals and navigations in the United Kingdom for 1888, in which the capital, dividends, traffic, revenue, expenditure, method of traction, length of the navigation, number and dimensions of the locks, length of the tunnels, with the width of the waterway and minimum headway above the water-level in them, the supply of water, and the dimensions of the largest barges that can pass, are furnished in tabular form for each canal and navigation, the independent canals being kept separate from the canals owned by railway companies. In 1895 the Federated Institution of Mining Engineers arranged a Conference on Inland Navigation, which took place during their Birmingham meeting, when several papers on canals and navigations in England were read and discussed; and the proceedings of the Conference were published,* to which a map of the canals and navigable rivers of England and Wales was appended, prepared and published by Mr. L. B. Wells in 1892.

Neglect of inland navigation on the introduction of railways, and a subsequent revival of interest in the subject have not been confined to Great Britain; for in France, for instance, public attention was for a time concentrated on railways, and some of the canals were allowed to pass out of the control of the State; but about 1860 a reaction commenced in favour of the maintenance and improvement of the waterways of the country, which has continued with increasing force ever since. In the United States, also, little effort was made for a long time to enlarge the existing canals to meet the growing requirements of the grain traffic, and some of the canals have passed into the control of the railways; but recently the deepening of the Erie Canal has been commenced, and proposals are under consideration for a considerable enlargement of the canai to accommodate the vessels navigating the Lakes. Germany also, since 1880, has spent large sums on the improvement of its inland waterways, with the object of increasing and cheapening the means of transport, and thereby promoting the prosperity of the country.

Interest also in the development of waterways, and the various matters relating thereto, has been strikingly manifested by the eight

"Report from the Joint Select Committee of the House ords and the House of Commons on Railway Companies algamation, 1872."

"Report from the Select Committee on Canals, Minutes vidence, 1883."

Journal of the Society of Arts, May 25, June 1 and 8, .

* The Federated Institution of Mining Engineers, "Report of the Proceedings of the Conference on Inland Navigation, Birmingham, Feb. 12, 1895, with Map of English Canals." Newcastle-on-Tyne, 1895.

international congresses, dealing mainly with inland navigation, held in the last 14 years, at Brussels in 1885, Vienna 1886, Frankfort 1888, Paris 1889, Manchester 1890, Paris 1892, the Hague 1894, and Brussels 1898, largely supported by the Governments of the respective countries of the Continent in which they were held, and attended by delegates from various parts of the world. These numerously attended meetings have led to the collection of a large quantity of information on inland navigation in different countries, the discussion from different points of view and elucidation of undecided matters of importance, and have afforded an insight into the conditions, practice, and progress in the improvement of the waterways of the countries visited.

INLAND NAVIGATION IN NORTH AMERICA.

Waterways from the Great Lakes to New York and Montreal.—The United States and Canada possess the finest chain of lake inland navigation in the world; and it has only been necessary to improve the connection between Lake Superior and Lake Huron, by the St. Mary Falls Canal, and between Lake Huron and Lake Erie by the St. Clair Flats Canal, to obtain an inland waterway from Chicago at the head of Lake Michigan, and from Duluth and Port Arthur, on Lake Superior, to Buffalo and the Erie and Welland Canals at the north-eastern end of Lake Erie. From thence, New York is reached by water along the Erie Canal and the Hudson River, and Montreal by the Welland Canal, Lake Ontario, and the St. Lawrence and its canals, avoiding the rapids of the river. The distance from the head of Lake Superior and from Chicago to Montreal by water, is about 1,280 miles, of which only about one-eighteenth is canal, the remainder being open river and lake navigation; whilst to the ocean, at the outlet of the Straits of Belle Isle, the distance is about 2,380 miles, 150 miles longer than from the Straits of Belle Isle to Liverpool. The distance from the heads of the lakes to New York is about 1,420 miles, out of which 352 miles are comprised by the Erie Canal; but with the exception of the St. Mary Falls Canal, only $1\frac{1}{4}$ miles long, and the cut along the St. Clair River into Lake St. Clair, known as the St. Clair Flats Canal, the rest of the distance is open lake and river. Lake Superior, however, is 602 feet above sea-level, the most abrupt change of level being encountered between Lake Erie and Lake Ontario, amounting to 326 feet, resulting in the Niagara Rapids and Falls. The difference in level between Lake Superior and the St. Law rence at Montreal, of 551 feet, is surmount by a large lock of 18 feet lift on the Canadia side of the St. Mary River, by 25 locks on th Welland Canal, $26\frac{3}{4}$ miles long, connectin Lake Erie with Lake Ontario, all compris within the 10 miles nearest Lake Ontario, an having a total lift of $326\frac{1}{4}$ feet, and the locks of the six lateral canals of the S Lawrence, $46\frac{1}{2}$ miles long altogether, whe the difference of level amounts to $206\frac{1}{2}$ fe Along the route to New York from Lak Superior there is a large lock on the America side of the St. Mary River with a lift of 18 fee as on the Montreal route; but there are locks to be passed on the Erie Canal betwe Buffalo on Lake Erie and the Hudson Riv at Albany. Moreover, the available depth the Erie Canal is only 7 feet, which is bein gradually increased to 9 feet, and the loc are 18 feet wide, and the available length the shorter ones is only 98 feet, admittin barges of 240 tons; whereas the availabl depth of the improved Welland and S Lawrence canals is 14 feet, in place of 9 fe formerly, and the locks are 270 feet long an 45 feet wide. The American St. Mary's Fa Canal and the Canadian Sault-Sainte-Mar Canal, having to accommodate the large lak traffic, have been recently provided with lock 800 feet long, 100 feet wide, and 21 feet dep of water on the sill, and 900 feet long, 60 fe wide, and $20\frac{1}{2}$ feet depth respectively.

Various Waterways in North America. The other Canadian canals of importance a the Ottawa canals, avoiding the rapids of th Ottawa River, with locks 200 feet by 45 fee and an available depth of 9 feet, and therel providing a navigable waterway betwe Ottawa and the St. Lawrence, and t Chambly Canal, 12 miles long, 7 feet dee and having nine locks of 118 feet by $23\frac{1}{2}$ fe forming part of the Richelieu Navigati connecting the St. Lawrence with La Champlain, and thence by the Champla Canal with the Hudson River.

Several canals were constructed in t United States in the earlier half of the prese century in addition to the Erie Canal, wi depths of four to seven feet, and locks rangin from 176 feet by 17 feet, to 78 feet by 15 fee having an aggregate length of 1,700 miles, about 2,100 including the Erie Canal and i branch to Oswego,* but they have for the mo

* "Respective Uses of the Waterways and Railways General Transportation in the United States," Thos. Roberts, Fifth International Congress on Inland Navigati Paris, 1892, p. 17.

part been superseded by railways. Canals, however, are by no means regarded as obsolete means of communication in the United States, for the Government engineers and others have been urging the construction of an improved waterway between the Lakes and the Hudson River, the need of which has been generally acknowledged; and the only question upon which a difference of opinion exists, is whether the Erie Canal should be enlarged and merely deepened to 12 feet, to accommodate barges of 1,500 tons, or a canal, 18 ft deep, should be constructed along a more suitable route, to admit larger vessels navigating the lakes, or a ship-canal, 24 feet deep, accessible for ocean-going steamers.* The Chicago Drainage Canal also has been made sufficiently deep to form the first section of an ample waterway between Lake Michigan and the Mississippi; whilst the Government is providing a similar connection on a more modest scale by the Illinois and Mississippi Canal, to join the Illinois River to the Rock River, at present in progress, 75 miles long and 7 feet deep, rising 196 feet by twenty-one locks, and then descending 93 feet by ten locks, and designed for the passage of 600-ton barges, 140 feet long, 34 feet beam, and 6 feet draught.†

Since the Government took the waterways under its control in 1860, its efforts have been mainly directed to the improvement of the chief rivers by dredging, removal of obstructions, the construction of lateral canals at places to avoid rapids, and the canalisation of several of the tributaries of the Mississippi and the Ohio. The rivers are free; and the tolls were abolished on the Erie Canal in 1882.

Traffic on United States Waterways.—The traffic of the principal waterways of North America, is indicated by the thickness of the red bands following the lines of these waterways on Diagram 1, shown on the wall. The traffic on the open lakes is naturally very large, being greatly assisted by the improvements in the communications between them, the amount passing out of Lake Superior by the St. Mary's Fall Canal, having reached 8,288,000 tons in 1890; and this traffic being increased by the accession of traffic from Lakes Michigan and Huron, attains a maximum, where it can be measured in passing through the St. Clair Flats Canal at the Detroit River, which was about 20,000,000 tons in 1890 reaching Lake Erie. On leaving Lake Erie, it is dispersed, the greater portion going on to the railways at Buffalo, and, to some extent, at other parts on the lake, only between 3,000,000 and 4,000,000 tons going on by water along the Erie Canal, and about 1,000,000 tons by the Welland Canal. The Hudson River, between Albany and New York, has a traffic which amounted to 18,600,000 tons in 1890, second only to the traffic passing between Lake Huron and Lake Erie, owing to its being a large open waterway in direct communication with New York and the sea to the south, and with the Erie and Champlain Canals and Albany, Troy, and other important towns to the north. The Ohio flowing through the most flourishing and populous portion of the United States, is, next to the lakes and the Hudson, the most important waterway, having a traffic of about 6,000,000 tons between Pittsburg and its confluence with the Mississippi at Cairo, a distance of 967 miles—a much longer length of navigation than on the Hudson. The Mississippi has a good traffic between St. Paul and its mouth, a distance of 1,950 miles, ranging from a maximum of 4,131,000 tons between St. Louis and Cairo, with a minimum of 2,862,000 tons between New Orleans and its mouth. Several comparatively short waterways, tributaries of the Ohio and rivers connecting important towns with the sea, have a considerable traffic of between 1,000,000 and 5,000,000 tons; but the only other long waterways of any consequence are the Arkansas River, with a traffic of 1,700,000 tons, and the Missouri, remarkable rather for the great distance its navigation extends up the river than for its traffic, which drops from 849,000 tons to quite a small amount above the mouth of the Big Sioux River. The waterways whose traffic is under 100,000 tons have been omitted from the diagram; and considerations of space have necessitated leaving out the few waterways on the Pacific Coast, of which the Columbia River, up to Portland, with a traffic of 1,633,000 tons, and the Sacramento and San Joaquin rivers, near San Francisco, with 1,006,000 tons and 350,000 tons respectively, are the only ones of importance.

Traffic on Canadian Waterways.—The Welland Canal, affording a navigable waterway between Lakes Erie and Ontario, and therefore forming a link between Lake Superior and the St. Lawrence, has the largest traffic, somewhat exceeding 1,000,000 tons;

* "Report of the Chief Engineers, U.S. Army, 1897," Part 4, pp. 3328–3265; and Transactions of the American Society of Civil Engineers, vol. xxxix., pp. 273-322.

† "Report of the Chief of Engineers, U.S.A., 1897," Part 4, p. 2825-2879, with map and Longitudinal Section of Canal.

the St. Lawrence and its canals, between Lake Ontario and Montreal, have a traffic of between 800,000 and 900,000 tons; the Ottawa River and its canals between Ottawa and the St. Lawrence, have a traffic of between 500,000 and 600,000 tons; and the Chambly Canal, on the route between the Hudson and the St. Lawrence, has a traffic of between 200,000 and 300,000 tons.*

Remarks on North American Waterways.—In spite of very keen railway competition, the waterways possess a large traffic where the rivers pass through a populous district, and there is a large supply of bulky goods, provided even a very moderate depth can be secured. The great improvements also in the connections between the lakes has enabled a large trade to be attracted to the through route between Lake Superior and Lake Erie, notwithstanding its being closed by ice during four or five months in the year. The great diversion of the lake traffic to railways at Buffalo, though largely caused by the antiquated condition of the Erie Canal, in view of the increased requirements of shipping, is also due to the railways having established lines of vessels of their own on the lakes as feeders of their traffic. The small traffic on the Welland Canal, as compared with the Erie Canal, in spite of its larger dimensions, may be traced to 89 per cent. of the vessels navigating the lakes belonging to the United States, and also to the Soulanges Canal, the final link in the enlargement of the St. Lawrence Canals, not having yet been opened for traffic. If Canadian lines of steamers, built for passing through the improved waterway between Lake Erie and Montreal, are put on the lakes, the traffic is quite certain to increase with the development of Western Canada.

The traffic on all the inland waterways of the United States has been estimated at 25,000,000,000 ton-miles, or nearly one-third the number of tons carried one mile on the railways.† The average length of journey of the lake traffic has been reckoned at 566 miles.

Inland Navigation in Germany.

Navigable Rivers in Germany.—Germany possesses the advantage of being traversed by some large rivers which, rising in countries to the south, have their lower and more navigable portions situated in Germany, thereby providing important natural waterways, notably the Rhine and the Elbe, and in a smaller measure the Oder, the Vistula, and the Niemen. These rivers, with their principal tributaries, and the comparatively short canals connecting them, constitute the main inland waterways of the country. The Weser, situated wholly in Germany, and the Danube rising in it, are relatively of little importance as German inland waterways; whilst navigation along the valley of the Ems, a wholly German river, has had to be provided for the most part by a lateral canal.

The main rivers, with the exception of the Ems, are open navigations, and also some of their chief tributaries, having been improved by regulation works and dredging; but the available depth naturally decreases on ascending the river. A few of the principal tributaries of the large rivers have been partially canalised, namely, the Lippe, the Ruhr, the Lahn, the Main, and the Saar in the Rhine basin, the Elde, the Spree, the Havel, and the Saale in the Elbe basin, and the Netze in the Oder basin. The sizes of the locks on these canalised portions have been determined by the depth of the waterway and the importance of the traffic, varying from 90 feet in length, $15\frac{3}{4}$ feet in width, and $3\frac{1}{2}$ feet depth on the sill, up to the Spree lock, 361 feet by $31\frac{1}{2}$ feet and $6\frac{1}{4}$ feet depth at the low stage, and the five lengthened locks on the Main, between its mouth and Frankfort, 1,148 feet by $34\frac{1}{2}$ feet and $8\frac{1}{5}$ feet depth.

Canals in Germany.—Most of the canals in Germany have been constructed to connect two river navigations across the waterparting of their valleys. Thus, the Rhine-Marne and the Rhine-Rhone canals, starting from the Rhine near Strassburg, connect the Rhine with two main French river basins; the Ludwig Canal, $83\frac{1}{2}$ miles long, and having a summit-level 1,372 above sea-level, connects the Main and the Danube through the canalised Altmühl; the Finow Canal joins the Oder to the Havel, and consequently to the Elbe, and the Oder-Spree Canal also furnishes another connection between the same rivers; whilst the Vistula-Netze Canal connects the Vistula with the Oder. Thus the Elbe, the Oder, and the Vistula are connected; but there is no regular inland connection between the Rhine, the Ems, the Weser, and the Elbe. A mid-land canal, however, has been proposed, which, starting from the Elbe below Magdeburg, and passing

* "Annual Report of the Minister for Railways and Canals, 1895-96," Ottawa, Appendix A, p. 154.

† "Relations Between Railroads and Waterways in the United States," E. P. North, Fifth International Congress on Inland Navigation, Paris, 1892, p. 2.

by Hanover, would cross the Weser near Minden, and after joining the Ems lateral Canal at Rheine, would make use of this canal as far as Henrichenburg, and thence by a prolongation along the valley of the Emscher, would join the Rhine near Ruhrort, and thereby complete the connection between all the main German rivers.

The Ems-Jade Canal has a depth of nearly 7 feet, and the Oder-Spree Canal a depth of $6\frac{1}{2}$ feet, whilst the Ems Canal has been made $8\frac{1}{5}$ feet deep; but most of the other canals have depths of between five and six feet. The locks on the canals vary considerably in dimensions, according to the importance of the navigation or the date of construction, ranging for the most part between 105 feet by $15\frac{1}{5}$ feet, with a depth of $4\frac{1}{3}$ feet, the size of the 100 locks on the Main-Danube Canal, and 180 feet by $28\frac{1}{4}$ feet, with a depth of $8\frac{1}{5}$ feet for the seven locks on the Oder-Spree Canal; but there are a few smaller locks than those on the Main-Danube Canal, and the largest canal locks are the nine locks on the Ems Canal, 541 feet long, 33 feet wide, and $8\frac{1}{5}$ feet in depth.

Length of German Waterways.—The total length of rivers used for inland navigation is 5,100 miles, of which only between one-sixth and one-seventh consists of canalised rivers; while the inland canals have a length of about 1,300 miles, making altogether about 6,400 miles of inland waterways in Germany.

Traffic on German Waterways.—The Rhine with its large open waterway has attracted the largest amount of traffic, especially between the Dutch frontier and Ruhrort; and the traffic continues large up to Mannheim, for the minimum depth at the lowest stage, which is 8 feet up to Cologne and $7\frac{1}{4}$ feet to above Coblentz, does not fall below $6\frac{1}{2}$ feet as far up as Mannheim, except for a short distance near St. Goar. The Elbe also possesses a large traffic all the way between Hamburg and the Austrian frontier, for it connects Hamburg, the largest seaport of continental Europe, with Magdeburg, Dresden, and Bohemia, and also these places with Berlin by the Plaue Canal, the Havel, and the Spree. There is a fair traffic on the Oder between Stettin and Breslau, and on its connections with Berlin; and there is a moderate traffic on the Vistula between Dantzig and the Russian frontier, and the waterway connecting it with the Oder, and on the short portion of the Niemen in German territory and its connection with Königsburg. There is also a good traffic on the canalised Saar, the Saar Canal, and the Rhine-Marne Canal, which is increasing, in spite of the summit-level of this latter canal, reached by 51 locks from the Rhine, being 878 feet above sea-level; but the traffic on the Rhine-Rhone Canal, whose summit-level is 1,143 feet above sea-level, and is reached by 85 locks, is small, owing mainly to the small importance of the Rhone basin in regard to inland navigation, as well as the great difference in level that has to be surmounted. The traffic on the Main between the Rhine and Frankfort, which, before it was canalised, was smaller than higher up, has greatly increased since the works were completed in 1886, in spite of the railways on either bank, as along the Rhine; and this result has been experienced in other improvements of large waterways in Germany, and has no doubt led to the provision of the large waterway to Dortmund along the Ems valley, where formerly the traffic was very small. The traffic on the other German waterways is comparatively insignificant, and has not been indicated on the diagram where less than 100,000 tons.

On the average, the goods traffic on the German navigable waterways is rather greater in proportion to their length than on the German railways; and the average journey by water of 217 miles, is about double the average journey of goods by railway; but owing to the much greater length of the railways, the traffic on the waterways is only about one-third of the goods traffic on the railways.

Remarks on German Waterways.—The Government not only maintains the existing waterways in Germany, but also spends large sums of money every year in their improvement and extension, though all the main lines of railway and numerous branch lines are owned by the State. In consequence, the inland navigation traffic has greatly increased in recent years, in spite of the waterways being closed for about three months in the year. Tolls are levied on the canals and canalised rivers, but hardly amount to one-third of the costs of maintenance. The view entertained, however, is that certain classes of goods are carried more economically by water, that the railways do not suffer from the improvement, and consequent increased traffic of the waterways, and that the extension of the means of communication of a country is a public benefit, and promotes trade and agriculture.

Inland Navigation in France.

France is the country in Europe in which

inland navigation has been most carefully attended to. Like England, it possesses no rivers which were naturally navigable for long distances inland; and it also possesses an extensive seaboard, for the sea constitutes more than half of its entire boundary; while the connection of its river basins by waterways involved surmounting considerable elevations.

Navigable Rivers in France.—There are four main river basins in France—namely, the Seine, the Loire, the Garonne and Dordogne, which join to form the Gironde, and the Rhone. The Seine, which has been made accessible for sea-going vessels up to Rouen, has been canalised from Rouen up to Montereau, a distance of 214 miles, giving a minimum depth of 10½ feet between Rouen and Paris, and 6½ feet between Paris and Montereau. Its tributaries also, the Oise with the Aisne, the Marne, and the Yonne, have been made first-class waterways, with a minimum depth of 6½ feet, by canalisation for considerable distances; and the main river and its tributaries are more or less navigable a good way further up.* The navigation of the Loire above Nantes is greatly impeded by the rapid current and the variable and defective depth; and no portions of the Loire above Nantes, or of its tributaries are first-class waterways, with an available depth of 6½ feet, though considered navigable as second-class waterways for long distances inland. The tidal Garonne and Dordogne are first-class waterways from their confluence in the Gironde up to Castets and Libourne respectively; but above these places they and their tributaries are second-class waterways. The canalised Saône from Corre to its junction with the Rhone at Lyons, a distance of 231 miles, is a first-class waterway, with a minimum depth of 6½ feet; but there is no other river in the Rhone basin which occupies this position; for the Rhone itself between Lyons and the sea, in spite of the extensive regulation works carried out and its fairly uniform flow, has a rapid current, and a depth in places of less than 6½ feet at a low stage. Accordingly, in contrast to Germany, the rivers of France have only been made thoroughly satisfactory waterways for inland navigation by means of canalisation.

Canals ia France.—Canals have been chiefly constructed in France as lateral canals to supersede defective river navigations, and to connect the navigations of different river basins across the waterparting of their valleys. Thus there are lateral canals to the Upper Seine, the Oise, the Aisne, the Marne, and the Yonne in the Seine basin, the Loire, and the Garonne; whilst the Upper Scheldt in France is connected with the Oise by the St. Quentin Canal. The Sambre, and therefore the Meuse, is also connected with the Oise by a canal; the canalised Meuse is connected with the Marne-Rhine Canal, and with the canalised Saône by the Canal de l'Est; and the Loire lateral Canal is connected with the Seine by the Briare and Loing canals, with the Yonne by the Nivernais Canal, and with the Saône by the Canal du Centre. The Yonne also is connected with the Saône by the Bourgogne Canal the Marne is being joined to the Saône by a canal approaching completion, and the Garonne lateral Canal is in communication with the Mediterranean by the old Canal du Midi. The summit-level of the southern branch of the Canal de l'Est is 1,184 feet above the sea, of the Bourgogne Canal 1,241 feet, of the Nivernais Canal 858 feet., of the Canal du Centre 989 feet, and of the Canal du Midi 610 feet. With the exception of the Upper Seine lateral Canal, the Sambre-Oise Canal, part of the Loire lateral Canal, the Nivernais Canal, and the Garonne lateral and Midi canals, the canals named above are in the first-class, namely, canals which have a minimum depth of water of 6½ feet, and locks of not less than 126⅓ feet available length, and 17 ft. width, and affording a minimum headway under bridges of 12⅛ feet Canals, and also rivers, of the second-class are those whose depth or locks do not come up to these dimensions; whilst there is a third class of rivers only suited for having goods floated down them. The canals are almost entirely confined to the north-eastern and eastern central districts of France, with the exception of the Brest-Nantes Canal, the canal between Rennes and St. Malo, some short canals in the neighbourhood of La Rochelle and Rochefort, the Garonne lateral and Midi canals, and canals branching off from the Lower Rhone.

Lengths of French Inland Waterways.—The chief objects aimed at with regard to French waterways in the last forty years, have been the improvement of some of the principal rivers, the formation of important connections by canals, the repurchase by the State of conceded waterways, and especially, since 1879, the carrying out of the necessary works to make all the main lines of waterways compl

* "Guide Officiel de la Navigation Intérieure." Paris.

ith the standard dimensions given above for :st-class waterways determined in that year,) that barges of 300 tons may be able to averse all the main lines of navigation ıroughout the country. Since 1860, the Seine as been greatly improved by canalisation :tween Rouen and Montereau, as well as ›me of its tributaries; the Rhone has been :gulated between Lyons and Arles; and 528 iles of canals have been constructed.

The lengths of the French inland waterways :tually used for the transport of goods in 397, were 483 miles of rivers on which the oods had to be floated down, 4,120 miles of avigable rivers, and 3,014 miles of canals, aking a total of 7,617 miles.* Of this length waterways, 7,459 miles are owned by the :ate; and only 152 miles of the conceded ınals, and six miles of the canalised Lez are ıder other control at the present time, as the aronne lateral and Midi canals with their :anches, 306 miles in length, reverted to the :ate by purchase last July.

The progress made towards securing uni- rmity in dimensions along the main water- ays, as decreed in 1879, is manifested by comparison of the lengths of first-class rivers ıd canals in 1878 and 1897. These lengths ere 619 miles of rivers and 146 miles of ınals, or a total of 765 miles of first-class aterways in 1878, and 1,267 miles of rivers ıd 1,528 miles of canals (of which 401 miles ere constructed since 1878), or a total of 795 miles of first-class waterways in 1897, so at the length of first-class waterways con- rming completely with the standard dimen- ons is now over three and a-half times their ngth in 1878. The lengths of inland water- ays used for traffic in 1878 were 4,095 miles of vers and 2,616 miles of canals, or a total of 711 miles, as compared with 7,617 miles in 97, so that the first-class waterways were ·4 per cent. of the whole length in 1878, and ·7 per cent. in 1897.

Traffic on French Inland Waterways.— ıe large traffic on the waterways is almost ıolly confined to the waterways converging on ıris from the northern ports, from Belgium, ›m Germany by the Marne-Rhine Canal, and ›m Montereau and Rouen along the Seine, e only other waterways in France having a affic exceeding 500,000 tons being the route nnecting the Saône with the Seine through e Loire valley, and therefore the Rhone and Loire basins with Paris, by the Canal du Centre, the Loire lateral Canal, and the Briare and Loing Canals, and also the Berry Canal joining the Loire lateral Canal below Nevers. The largest traffic, as shown by the thickness of the red bands on Diagram 3, clusters round the neighbourhood of Paris, where the various streams of traffic concentrate, converging mainly to the environs of Paris, and also diverging by three principal lines, namely, by the St. Quentin Canal and the Oise, with a maximum of 4,604,000 tons in 1897 on the canal near Cambrai, by the Lower Seine with a maxi- mum of 4,152,000 tons between Conflans and La Briche, and by the Upper Seine with a maximum of 2,632,000 tons between Corbeil and Paris; whilst the traffic by water within the Paris section was 3,594,000 tons in 1897. The traffic of all the French waterways, down to 100,000 tons, is indicated by red bands on Diagram 3 on the wall; whilst the course of some of the long canals with an insignificant traffic, such as the Garonne lateral and Midi canals, the Rhone-Rhine Canal, and some canals in the extreme west, is indicated by red lines. Traffic exceeding 100,000 tons was carried in 1897 along a length of 3,205 miles of river navigations and canals, which is less than half the length of the navigable waterways.

The total tonnage of goods carried on the French waterways in 1897 amounted to 30,125,000 tons, one-third of which consisted of building materials, over 28 per cent. of coal, 13·7 per cent. of agricultural products and provisions, 7·7 per cent. of timber, and the same of metals, and 5·4 per cent. of manures. The traffic in 1897, reckoned by the number of tons carried one mile, was 2,669,870,000 ton-miles; and consequently the average tonnage throughout, assuming it was evenly distributed over the whole length of waterways traversed, was 350,500 tons; whilst the average journey, obtained by dividing the ton-miles by the total actual tonnage, was 88 miles.

The waterways were separated by the decree of 1879 into main and secondary lines; and the large traffic is confined to the principal lines, and for the most part to those which conform to the dimensions of first-class water- ways, the only exceptions being the Sambre-Oise Canal, the Ourcq and Berry Canals, and a portion of the Loire lateral Canal. There are at present 3,732 miles of main waterways, which, however, do not all as yet conform to the standard dimensions, and 3,885 miles of secondary waterways; and the large increase

* "Statistique de la Navigation Intérieure, Ministère ; Travaux Publics, 1897." Paris, 1898.

in the average traffic, and in the number of ton-miles in the last 25 years, has been almost wholly restricted to the main lines, the increase having mainly occurred since 1880, when tolls were entirely abolished, and the improvements decreed in 1879 were beginning to be brought into operation. Thus, in 1880, when there were 3,461 miles of main waterways, and 3,337 miles of secondary waterways, the number of tons carried one mile and the average traffic were 1,142,000,000 ton-miles and 330,000 tons on the main lines, and 85,500,000 ton-miles and 25,500 tons on the secondary lines; whilst in 1897, the corresponding quantities were 2,552,000,000 ton-miles and 684,000 tons on the main lines, and 118,000,000 ton-miles and 30,500 tons on the secondary lines. Acoordingly, the traffic on the main lines has more than doubled in 17 years; whereas the traffic on the secondary lines has only increased 20 per cent. in the same period, though owing to the augmentation of 16 per cent. in their total length, the increase in their ton-miles has been 38 per cent., as against an increase of over 123 per cent. on the main lines. The proportions of the traffic carried by the main and secondary waterways respectively, which were 93 per cent. and 7 per cent. in 1880, amounted to 95·6 per cent. and 4·4 per cent. in 1897, which proves that in spite of the present greater length, and greater increase in the length since 1880 of the secondary waterways than of the main lines, there is a very great preponderance of traffic on the main waterways, which is actually on the increase.

The length of the average journey is gradually increasing, having been $68\frac{1}{3}$ miles in 1881, the first year in which complete returns were made, $82\frac{3}{5}$ miles in 1886, averaging 87 miles from 1891 to 1896, and reaching $88\frac{3}{5}$ miles in 1897. The increased average tonnage on the various sections of the waterways in 1897, as compared with 1882, is shown on Diagram 3 by the amount by which the red bands overlap the purple bands which represent the traffic in 1882. The increase is most marked in the lines converging to Paris, especially the waterways from the northern ports, the Oise, the Seine, the Aisne and Marne canals to the Rhine, and the northern part of the Canal de l'Est; whilst the small traffic on the Rhine Canal and the Garonne lateral and Midi Canals has decreased since 1882.

Remarks on French Waterways.—In spite of the care expended in improving, completing, and giving uniformity of dimensions to the waterways during the last twenty years, the traffic is very unevenly distributed, being concentrated on the portion of France north of Montereau; whilst except along the waterway joining the Seine, the Loire, and the Saône, with its branch the Berry Canal, the traffic is very small elsewhere. Two diagrams have been published by Mr. Nördling showing the traffic on the railways and waterways of France in 1882 side by side,* from which it is evident that the railway traffic, though more concentrated in the northern and north-eastern portions of the country than elsewhere, is far more evenly distributed than the inland navigation traffic, having a large traffic between Paris and Marseilles, following the Rhone valley between Lyons and Arles, and also between Avignon and Toulouse and on to Bordeaux and between Bordeaux and Paris along routes where the inland navigation traffic is insignificant.

Inland Navigation in Belgium.

Belgium is very well supplied with waterways in proportion to its area, being traversed for a portion of their course, by the Scheldt and its tributaries, and by the Meuse and its tributary the Sambre, which have been canalised and numerous canals have been constructed especially in the flat western half of the country.

Lengths of Waterways, and Standard Dimensions.—The length of navigable waterways in Belgium is reckoned at 1,365 miles consisting of 765 miles of rivers and 600 miles of canals, in which there are 123 miles of river on which goods can be only floated down, 30 miles of open navigable rivers, 341 miles of canalised rivers, 143 miles of small canals, and 457 miles of canals accommodating barges of over 200 tons.† In 1830 the State had control of only 97 miles of waterways out of a total length of 1,006 miles, or 9·6 per cent.; but now the State controls 1,118 miles, or 82 per cent having regained possession of some waterways, repurchased others, and constructed new canals.

The standard dimensions, in accordance with which Belgian canals have been constructed of late years, are, bottom width 345 feet, depth 8 feet, and headway under bridges 13 feet, and

* "Die Selbstkosten des Eisenbahn-Transportes und der Wassen-strassen-Frage in Frankreich, Preussen, und Oesterreich," W. von Nördling, Vienna, 1885.

† "Guide Programme, VIIme Congrès International de Navigation," Brussels, 1898, p. 6.

the locks, 134 feet available length and 17 t width, and sills lower than the bed of the nal.

Traffic on Belgian Inland Waterways.—atistics of inland navigation in Belgium have en collected regularly since 1879; but it is ly since 1888 that the returns of inland navition traffic have been completely separated om sea-going traffic. The length of the aterways for which the returns are made is ly 1,012 miles, composed of 535 miles of ers and 477 miles of canals.* The Belgian aterways are so intimately connected with e French waterways that their traffic has en conveniently exhibited on Diagram 3. ie traffic consists of coal and coke, building aterials, metals, minerals, pottery, glass, gricultural and industrial products, and nber. The traffic is largest on the portion the tidal Scheldt between Antwerp and e mouth of the Rupel, where it nearly aches 2,750,000 tons; it is about 1,500,000 ns on the Scheldt below Antwerp, on the upel, and on the Brussels-Rupel Canal; exceeds 1,000,000 tons on the Maestcht-Bois-le-Duc Canal, and nearly aches this amount on the Lower Scheldt id the Liége-Maestricht Canal; it exceeds 0,000 tons on the Meuse-Scheldt Canal id the canalised Meuse, and nearly attains is quantity on the canalised Sambre; hilst the Charleroi-Brussels Canal and the pper Scheldt have an average traffic of ver 500,000 tons, and most of the other entral waterways have a traffic of between 0,000 and 500,000 tons. On the other hand, ie branch canal to Hasselt has an insignificant affic; and all the canals between the Ostendhent Canal, the Lys, and the French frontier ppear to be devoid of traffic.

There was a considerable increase in traffic n most of the waterways between 1888 and 896, exceeding 50 per cent. in some important istances; whilst the actual tonnage carried n all the waterways included in the returns, icreased from 24,444,000 tons in 1888 up to 3,816,000 tons in 1896, and the traffic from 59,500,000 ton-miles in 1888 up to 489,000,000 on-miles in 1896, being an increase of 36 per ent. in eight years. The average density of ie traffic also, assumed to be distributed over ie whole length of the waterways, rose from 59,000 tons in 1888 to 483,000 tons in 1896. he average journey must necessarily be short 1 a country of such small extent as Belgium; and as no material extensions of the waterways have been made within the period over which the exact returns extend, the length of journey has remained fairly uniform, ranging between 13·8 and 14·7 miles, with an average of 14·35 miles.

Remarks on Belgian Waterways.—Considering the limited area of Belgium, the length of its navigable waterways is large and the traffic on them is considerable; whilst, like in Germany and France, the traffic is concentrated on the lines converging to Brussels and the chief industrial and mining centres, and the main waterways connecting important towns, or leading from them to convenient ports on the seacoast. This traffic, moreover, has been obtained in spite of a very complete network of State railways; for in Belgium, as in Germany and Russia, the Government considers that the simultaneous improvement and extension of waterways and railways conduce to the development of trade, and the general prosperity and advancement of the country.

* Guide Programme, VIIe Congrès, p. 201.

Inland Navigation in England.

The conditions of the United Kingdom in respect of inland navigation differ somewhat from those of the other countries dealt with, in having a considerably larger extent of seacoast in proportion to the area of the country, in having a greater number of navigable tidal firths and inlets, and owing to London, Edinburgh, Dublin, Liverpool, Glasgow, Belfast, and several of the other most important towns being situated within easy access of the sea, to which Manchester has been recently added by the construction of its ship-canal.

Scotland, though lavishly supplied by nature with firths and lochs, penetrating in some cases a considerable distance into the interior, is not well suited for inland navigation, owing to its hilly character, the small size of its rivers, and the absence of inland mining and industrial centres. It possesses only five canals, with a total length of 122 miles, only two of which, connecting Edinburgh and Glasgow by a waterway across the country, have a traffic exceeding 100,000 tons, namely, the Forth and Clyde Navigation, with about 1,250,000 tons, and the Edinburgh and Glasgow Union Canal with about 130,000 tons, both belonging to railway companies.

Ireland, with the Shannon, the Barrow, the Bann, and the Boyne, the Grand Canal connecting Dublin with the Shannon, 79¼ miles long, the Royal Canal, 96 miles long, going

from Dublin into County Longford, and some other waterways, posseses 610 miles of inland navigation. Owing, however, to the absence of mineral resources and manufacturing centres in the interior, the traffic on the waterways, as given in the returns of 1888, amounts altogether to little more than half a million tons, only two waterways having a traffic exceeding 100,000 tons, namely, the Grand Canal with about 230,000 tons, and the Lagan Canal with 140,000 tons.

Wales, with its hills and absence of fair-sized rivers, is badly adapted for inland navigation, which comprises only four waterways in the south, two of which communicating with Cardiff and Swansea have a good traffic, and two branches of the Shropshire Union Canals in the north. Accordingly, the main interest in inland navigation, as regards the United Kingdom, is centered in England.

Traffic on Inland Waterways in England.—The canals and navigations of England have been to a great extent described in the evidence given before the Select Committee on Canals in 1883, and in the papers read at the canal conferences held here in 1888, and in Birmingham in 1895; and their positions are shown on Mr. Wells' diagram map. It will therefore suffice to draw attention to the distribution of traffic upon them, as indicated on the wall diagram, prepared from the traffic returns of 1888, for those waterways whose traffic is given as exceeding 100,000 tons.* The returns only give the actual tonnage carried on each separate waterway, and not the ton-miles or the distance along which a given tonnage is conveyed, as furnished for the other countries of which diagrams of traffic are exhibited. Accordingly, in default of proper statistics, the thickness of the band indicating the amount of traffic has had, in most cases, to be made uniform throughout the whole length of each waterway, as if the tonnage given traversed the whole distance, which is generally not the case; but, in a few instances, where the existence of branches converging on to a main line, or other circumstances, give evidence of a variation in the amount of traffic along different portions of a waterway, the thickness of the band has been modified to be more nearly in accord with the actual conditions. Though, however, it is impossible to make a correct diagram of the traffic on t[illegible] English waterways, comparable to the oth[illegible] diagrams, in the absence of any returns as [illegible] the actual tonnage traversing the differe[illegible] sections of each waterway, or to form a prop[illegible] idea of the amount of the traffic and of [illegible] intensity in different places without any indic[illegible]tion of the ton-mileage and the avera[illegible] journey, the diagram shows clearly enough t[illegible] situation of the waterways whose traffic is larg[illegible] The inland navigation traffic in England, as [illegible] the other countries referred to, is eviden[illegible] very unevenly distributed; but whereas in t[illegible] other countries, the traffic is chiefly conce[illegible]trated round the inland capitals, in Englan[illegible] since London has direct access to the sea, t[illegible] main traffic is concentrated around the midla[illegible] and northern inland towns which are mini[illegible] or manufacturing centres, such as Birmin[illegible]ham, Wolverhampton, Leeds, Sheffield, Roc[illegible]dale, Wigan, Stoke, and Northwich. T[illegible] Grand Junction Canal, with apparently [illegible] increasing traffic as it approaches London, [illegible] the only important waterway having a traf[illegible] of over 1,000,000 tons which extends into t[illegible] southern portion of England, which, howev[illegible] is exceeded by the short Regent's Canal [illegible] London. The only other waterways south [illegible] Birmingham whose traffic exceeds 500,000 to[illegible] are the Staffordshire and Worcestershire Can[illegible] connecting Stafford and the Potteries with t[illegible] Lower Severn at Stourport, only about a quart[illegible] of which is south of Birmingham, the Riv[illegible] Lee Navigation connecting Hertford wi[illegible] London, and the Thames Navigation betwe[illegible] Oxford and London, for the traffic on t[illegible] Oxford Canal does not quite reach this amour[illegible] whilst the traffic on the rest of the southe[illegible] waterways in England is very small. T[illegible] large traffic in fact on the English waterwa[illegible] with the exceptions mentioned above, is co[illegible]prised within the district bounded by the B[illegible]mingham and Shropshire Union Canals, t[illegible] Leeds and Liverpool Canal, the Aire and Cald[illegible] Navigation, the Don Navigation, a line fr[illegible] Sheffield to Stoke, and the Trent and Mers[illegible] Navigation. None of the systems of wate[illegible]ways within this area have a traffic of less th[illegible] 100,000 tons, only three less than 500,000 to[illegible] seven of between 500,000 and a 1,000,000 to[illegible] three of between 1,000,000 and 2,000,000 to[illegible] three of between 2,000,000 and 3,000,000 to[illegible] and the Birmingham Canals having a traffic [illegible] 7,750,000 tons. Moreover, out of a total traf[illegible] for England and Wales of 34,750,000 to[illegible] 23,500,000 tons, or rather over two-thirds [illegible] the whole, belong to the waterways of th[illegible]

* "Returns made to the Board of Trade in respect of the canals and navigations in the United Kingdom for the year 1888," London, 1890.

ited district, having a length of only 624 es out of a total of 3,374 miles used for fic in England and Wales, or less than one-1 of the whole; whilst only 1,975 miles of erways have a traffic exceeding 100,000 s in any part of their system, or rather less n three-fiths of the whole length.

'he large traffic in the districts lying ween Birmingham, Liverpool, Leeds, Goole, l Sheffield, cannot be attributed to the com-diousness of the waterways; for though un-ıbtedly these waterways are the most sperous, and probably possess the greatest ısity of traffic, which in the case of the aver Navigation and the Aire and Calder vigation have been improved and enlarged meet the requirements of the traffic, and ve locks 220 feet long, 42 feet wide, and 15 t of water over the sill, and 202 feet by 18 feet 8½ feet respectively, the rest of these water-ys have locks only 61 to 80 feet long 7⅙ feet, feet, or 17 feet wide, and depths rang-; for the most part between 3½ and 5 feet. fact, with the exception of the Weaver and e and Calder Navigations, and the widen-; of the locks and a few improvements on ne of the other waterways, little has been ne to meet the increasing requirements of de, and to compete on favourable terms h the railways for the bulky traffic; and it remarkable that, in spite of the great velopment of railways and the facilities they er, the antiquated waterways should have ained so much traffic.

Remarks on English Inland Waterways.

The inland navigation traffic in England, in France, is very unevenly distributed; for, cept along two or three waterways leading London, the waterway connecting Birming-m and the Potteries to the Severn, and two ort waterways communicating with Cardiff d Swansea, the bulk of the traffic clusters ınd Birmingham and Wolverhampton, Staf-dshire, Cheshire, and the southern portions of rkshire and Lancashire, where the chief neral and manufacturing inland centres are uated, and the routes by which access is tained by them to seaports. Whereas, how-er, in France every effort has been made thin recent years to give uniformity in nensions to the main waterways, and to omote inland navigation, and almost the ıole of the waterways have been brought der a single control, little has been done in ıgland to procure uniformity or to enlarge ough routes, except the Weaver and Aire d Calder Navigations, or till quite lately to take waterways out of the hands of railway companies, and to secure undivided control of main lines of navigation belonging to different companies.

In 1895 a Sheffield syndicate, constituted under the name of the Sheffield and South Yorkshire Navigation Company, purchased the Don Navigation, connecting Sheffield, Rotherham, Barnsley, and Doncaster with the Trent at Keadby and the Ouse at Goole, from the Manchester and Sheffield Railway Company. The Grand Junction Canal Company also has recently acquired control of the tolls between Birmingham and London, by arrangement with the Oxford, Warwick and Napton, and Warwick and Birmingham Canal Companies, and has obtained powers to quote through rates for the conveyance of coal from the Derbyshire coalfields to London, by making agreements with the Leicester and Loughborough Navigations and Erewash Canal Companies. Moreover, in order to expedite the traffic on this latter route, a lift is being erected at Foxton, in place of a flight of ten locks with a total rise of 75 feet. These are steps in the right direction, placing navigations in the hands of bodies who will be interested in developing them; but these are only two out of several main routes greatly needing similar arrangements. Much, moreover, requires to be done to make these routes thoroughly satisfactory waterways, capable of accommodating a large traffic. The Don Navigation has, indeed, the good available depth of 6½ feet, and width of locks of 17 feet, corresponding to the standard dimensions on the main French waterways; but the length of the locks is only from 61 to 69 feet. The Grand Junction Canal also, which accommodates vessels 72 feet long, 14 feet beam, and 4 feet draught, has a link, known as the Grand Union Canal between Long Buckby and Foxton, connecting it with the Leicester Navigation, where the width of lock is only 7¼ feet; whilst the new waterways, over which the company has acquired control, have locks similar in dimensions to the main route, but an available depth of only 3½ feet. The canals also forming its route to Birmingham, have locks giving an available width of only seven feet and depth of 3¾ feet. These waterways leading to Birmingham have a moderate traffic, though some of it must follow the Oxford route; but the Grand Union Canal and the Leicester and Loughborough Navigations have a traffic of under 100,000 tons, and the Erewash Canal only slightly over this.

These routes furnish an illustration of the want of uniformity on the main routes of English waterways.

Comparison of Railways and Waterways.

A Table has been drawn up giving a few statistics furnishing a comparison, as regards length, traffic, and average journey, between the railways and waterways in England, France, Belgium, and Germany. The absence of proper returns has rendered it impossible to complete the statistics for England. The Table shows that England, including Wales, has a much larger railway mileage in proportion to its area than the other countries, and that Belgium comes nearest to it; but that Belgium possesses the largest proportion of waterways to area, and that England comes second, considerably in advance of France, and with nearly double the proportion of Germany. The actual railway mileage in England is only about two-thirds that of France and of Germany; but the mileage of the United Kingdom is only slightly less, having reached 21,433 miles in 1897. Holland, indeed, the land of canals, having 20 miles of waterways per 100 square miles, is far in advance in this respect of any other country;* but this very flat, low-lying country stands apart from other countries as regards its water communications, and does not afford a proper basis of comparison.

The absolute goods traffic is far larger on the railways in England than in France or Germany, and about nine times the traffic on the English waterways; but the actual weight of goods conveyed on the waterways in England was somewhat larger in 1888 than it is at present in France or Belgium, and much greater than in Germany, in spite of the great improvements effected in the waterways, and constant encouragement afforded to inland navigation on the continent. The large tonnage, indeed, carried on English waterways, in the face of culpable lethargy, great obstacles, and the unusual facilities offered by the railways, furnishes some indication of the very flourishing condition inland navigation would have attained in the mining and manufacturing districts o England, if anything like the energy displayed in railway extension had been devoted to making the old waterways suitable for modern requirements.

* "Rivers and Canals." L. F. Vernon-Harcourt, 2nd edition, 1896, vol. ii., p. 488.

Unfortunately there is no possibility o ascertaining the ton-mileage, the densit o the traffic, or the average journey of good on English railways and waterways, for compar on with similar statistics in other countries. It will be noticed that the average densit of the traffic, represented by the average tr ic per mile of way, is very similar for the railw s and waterways in France and in Germ y, though owing to the more central positio of Germany and the favourable conditions o ts large rivers, the traffic is larger there tha in France. The average traffic on the Bel n waterways is considerably larger than on e railways; but this difference would be consi r- ably reduced if the statistics had related to e whole length of waterways. The ton-mile e is the real measure of the traffic of the railw s and waterways of a country, as it depends u n the distances along which the goods are r- ried, as well as their amount; and it is e return from which the average traffic d average journey are deduced. The ton-m - age is in all three countries larger on the l- ways than on the waterways, a result natur y due to the greater length of the railways. b the density of the traffic is greater on the wa - ways of Belgium and Germany than on t i railways; whilst the average journey on e waterways of France, and notably on thos of Germany, is greater than on their railw s. The waterways in regular use in Fra e, Belgium, and Germany evidently carry t ir full proportion of the goods traffic; for t railways, which comprise 76·6 per cent. of e combined length of the railways and wa - ways of these countries, convey a traffic wh e ton-mileage amounts merely to 75·7 per c t. of the whole, so that the waterways carry a i per cent. more of the traffic than their p portionate amount according to their lengt

Conclusions respecting Inland Navi tion in England.

In all the countries which have been c sidered, a considerable inland naviga traffic exists; but the large traffic is confi to certain waterways suitably situated securing a large traffic in bulky goods. A in all these countries, with the exception England, after a period of indifference on advent of railways, strenuous efforts have b made in recent years to improve, render form, and complete the main waterways of country, thereby securing a benefit to the tr of the country, providing a useful autom check on the railway rates, and serving

AND GERMANY.

	England and Wales.		France.		Belgium.		Germany.	
Area	58,309 square miles.		204,146 square miles.		11,373 square miles.		211,168 square miles.	
Inland ways of communication	Railways.[1]	Waterways.[2]	Railways.[3]	Waterways.[4]	Railways.[5]	Waterways.[6]	Railways.[7]	Waterways.[7]
Date of statistics	1897	1888	1896	1897	1897	1896	1885	1885
Miles used for traffic	14,818	3,374	22,663[8]	7,617	2,075[9]	1,012[10]	23,000[11]	6,214[12]
No. of miles of way per 100 square miles.	25·41	5·79	11·10	3·73	18·24	8·90	10·89[11]	2·94[12]
Goods traffic in tons	315,876,500	34,325,200	102,403,000	30,125,000	33,202,000	33,816,000	98,420,000	13,500,000
No. of Tons carried one mile, or ton-miles	—	—	8,083,000,000	2,670,000,000	784,000,000[13]	489,000,000	10,151,000,000	2,935,000,000
Average traffic per mile of way in tons	—	—	357,000	350,000	378,000	483,000	441,000	472,000
Average journey in miles	—	—	78·9	88·6	23·6[13]	14·5	103·1	217·5

1 "Railway Returns made to the Board of Trade for the year 1897," London, 1898, p. xviii. 2 "Returns made to the Board of Trade in respect of the Canals and Navigations in the United Kingdom for the year 1888," London, 1890, p. 5; and "Map of Canals and Navigable Rivers of England and Wales," L. B. Wells, Manchester, 1892. 3 "Statistique des Chemins de Fer français au 31 Décembre, 1896," Paris, 1898, p. 179. 4 Statistique de la Navigation intérieure, Relevé général du Tonnage des Marchandises, 1897," Paris, 1898, vol. i., pp. 14 and 66. 5 "Chemins de Fer, Royaune de Belgique, Compte Rendu des Opérations pendant l'Année 1897," Brussels, 1898, pp. A 9 and A 10. 6 VIIe Congrès International de Navigation, Guide Programme, Bruxelles, 1898," pp. 204 and 206. 7 "Fourth International Inland Navigation Congress, Manchester, 1890," "Traffic on German Waterways for the years 1875 and 1885," Sympher, p. 4. 8 The French Railways consist of 20,768 miles conceded to private companies, and 1,895 miles of State railways. 9 In Belgium, 2,048 miles of railways are in the hands of the State, and only 27 miles belong to private companies. 10 The actual length of navigable waterways in Belgium is 1,365 miles; but returns are only rendered of 1,012 miles. 11 The length of railways open in Germany in 1896, was 28,071 miles, which gives 13·29 miles per 100 square miles. 12 The present length of inland waterways in Germany is about 6,400 miles, or 3·03 miles per 100 square miles. 13 As the number of ton-miles is not given in the returns of the Belgian railways, the average goods train journey has been taken as the nearest approximation available.

relieve the railways of somewhat burdensome traffic.

In the early days of canal enterprise, the waterways of a country formed the chief routes of economical carriage; but on the introduction of railways, the scope of waterways became necessarily restricted. Where the population is scattered and there is an absence of minerals or manufactures of bulky goods, and especially where the country is also somewhat rugged, a railway which can follow more nearly the irregularities of the surface, by gradients in place of level reaches, and can adopt a more direct course, serves more suitably the requirements of the district, and has better prospects of a return on the expenditure. Old waterways in such situations might advantageously be maintained, at a moderate cost, to serve the immediate district they traverse; but a large improvement of such waterways would not be economically justifiable.

In the present day, in face of the competition of railways, the primary requirement for a waterway is the existence of bulky goods which it may convey to large towns, or from inland mining or manufacturing centres to a seaport. Without such traffic, a very commodious waterway will languish; whereas with minerals or bulky manufactures, even a waterway of very inadequate width and depth may maintain a good traffic, as evidenced by the Birmingham, the Leeds and Liverpool, and other English canals. The second requisite, to enable a waterway to compete successfully with railways and enlarge its traffic, is uniformity of dimensions along the whole course of its main line, with a good depth and width, and ample size of locks, so as to afford a passage for large barges, and expedite their transit. Great differences of level on a waterway are prejudicial to its prospects of traffic; for not only do such conditions greatly increase the cost of first construction and subsequent enlargement, but unless inclines are adopted, or costly hydraulic lifts, there is a great delay in the passage through flights of locks and a large expenditure of water. Canals, under these circumstances, which might be expected to form useful links between important navigations, fail to attract trade, such, for instance, as the Ludwig Canal, connecting the Rhine and the Danube; whilst a second-class waterway, with a more moderate summit-level, may be preferred to a first-class waterway, as in the case of the Loire lateral Canal, which secures the greater part of the traffic between the Saône and the Seine, though there is a shorter and larger wat[...] by the Bourgogne Canal. Every improve[...] in the main waterways of Germany has [...] accompanied by a large increase in tr[...] and the enlargement, extension, and pro[...] towards uniformity of the main lines in F[...] and Belgium have been attended by a ren[...] able growth of traffic, as illustrated in [...] case of France by Diagram 3.

The experience gained from a review o[...] traffic returns of all the countries for w[...] such statistics are available, shows tha[...] improvement and unification of dimen[...] of English waterways should be confin[...] those waterways included within the zo[...] the mining and manufacturing centre[...] leading from them to the Mersey, the Hun[...] the Thames, and the Severn. These w[...] ways should form the subject of a careful [...] thorough inquiry, in order that the imp[...] ments needed, their extent, and their cost, [...] be accurately ascertained, as portions in [...] case of a complete scheme. England doe[...] possess the magnificent natural waterwa[...] North America, the large rivers of Germ[...] or even opportunities for such long arti[...] waterways as France; but it possesse[...] an eminent degree the requisite traffic, w[...] a limited region, in bulky goods, w[...] even the neglect of about three-qua[...] of a century has not sufficed to drive [...] from its antiquated waterways; and it is [...] dent that the enlargement of these waterw[...] if feasible within reasonable limits of expe[...] ture, would even at this late period, judgin[...] the experience of the Weaver, the Aire [...] Calder, and the principal waterways of Eur[...] be attended by most satisfactory results to [...] waterways themselves, the trade of the cou[...] and the population in general. If the fu[...] water-supply of London is considered of s[...] cient importance to engross the attentio[...] two Royal Commissions, it cannot be [...] much to ask that a Commission may [...] appointed to hold an inquiry on the [...] means of promoting inland navigation [...] the industrial centres of England, a [...] ject which has been considered worthy [...] the cordial support of the Governments in [...] other foremost countries of the world, [...] which has an important bearing on the tr[...] of the country and the general prosperit[...] the community. In the meantime, conside[...] that the statistics of the canals and navigat[...] of the United Kingdom are already ten y[...] old, are acknowledged to be incomplete, [...] do not afford any indication of the distribu[...]

the traffic on the several waterways, the ...ard of Trade might be urged to collect a ...sh set of complete statistics to assist the ...bours of the proposed Commission, to ...dicate the growth or decrease of traffic on the ...terways since 1888, and to afford suitable ...atistics as to the distribution of traffic on the ...terways, as furnished by the Governments of ...e United States, Germany, France, and ...lgium. Ways of communication are to a ...untry like the arteries to the body; and the ...terways which affect the central and most ...urishing and industrial portion of England ...nnot, any more than the arteries near the ...art, be suffered with impunity to be paralysed ... neglect.

DISCUSSION.

The CHAIRMAN said that having spent a large ...rtion of his life in the improvement of canals and ...ers, it was a great pleasure to him to take the chair ... that occasion, and he had listened to the paper ...th great interest, for it summed up the matter very ...mpletely, and he perfectly agreed with the con...sions arrived at. Mr. G. R. Jebb, engineer to a ...ge series of canals mentioned in the paper, carry...g a traffic of $7\frac{3}{4}$ million tons—the Birmingham ...nals and Shropshire Union connecting the Birming...m Canal with the Manchester Ship Canal, had ...itten the following letter:—

"18th January, 1899.

MY DEAR LEADER WILLIAMS,

"I am leaving this to express my regret that (at ...e last moment) I am prevented from being here to...ght to listen to Mr. Vernon-Harcourt's paper on ...nals, and to support you in the Chair. I shall ...ok forward with interest to seeing his paper in the ...*urnal* on Saturday. I trust he may have been ...spired to make some practical suggestion for the ...tterment of our poor, narrow canals. I confess the ...ore I study the problem the more of a pessimist I ...come—*i.e.*, so far as the enlargement of our narrow ...nals is concerned. I think some amelioration of ...eir condition may be effected by (1) the construc...n of lifts or inclined planes in lieu of locks, as is ...ing done on the Grand Junction, and as was con...mplated by the Birmingham Canal Company a few ...ars ago: Parliamentary plans were deposited for ...o inclined planes in the Black Country, but the Bill ...as not gone on with in consequence of the action of ...e Board of Trade with reference to canal tolls; ...d (2) by improvement in method of haulage: ...is, as you know, is a most difficult subject on the ...rrow shallow canals with locks about 7 feet 6 inches ...ide, and from 4 feet 6 inches to 5 feet of water on ...e sills. Mr. Parker, the eminent electrician of ...uthampton, went very thoroughly with me into the question of electrical haulage a few year ago, but failed to suggest a practical scheme. The problem is still being worked out by others. In the autumn of last year I made some experiments on the Birmingham Canal with "compartment" boats, similar in principle to that adopted so successfully many years on the Aire and Calder by Bartholomew. I shall go on with the experiments in the spring. One meets with a good deal of opposition from the boatmen, who look with much suspicion on any innovation.

"G. R. JEBB."

The Weaver Navigation, to which he (the Chairman) was engineer for seventeen years, had been prominently referred to; for that he designed and partly carried out certain improvements, which were continued by Mr. Wells, his successor, when he joined the Manchester Ship Canal, and the result showed what an advantage it was to increase the width and depth of a Navigation. When he joined in 1857, having previously assisted his father in improving the Severn Navigation, he found the traffic conducted in barges of from 60 to 70 or 80 tons, drawn by two horses, from Winsford to Weston Point, on the Mersey, from whence they went by the tide to Liverpool, the traffic, which was salt, being about $1\frac{1}{2}$ million tons a year. Much of the trade was carried by rail, and the owners of the navigation had to consider what should be done. He advised certain improvements, and the result was that to-day steamers carrying 200 to 300 tons, drawing 10 feet, passed down that canal, and each steamer towed two other craft behind, with an equal burthen, so that the gross amount was nearly 1,000 tons. The cost of taking it all the way from Winsford through the Mersey to Liverpool was something like 6d. per ton, and none of the railways carried salt to the docks at Liverpool; it all went by water. The railways could not compete at such a rate, and there was the additional advantage that warehouse room was saved, as the barges lay outside the ships, and discharged direct on board, whilst the other cargo was being loaded from the wharf. It was then his good fortune to be appointed to the Birmingham canals, and the question arose whether the traffic there could be improved. It would have been a very costly matter to introduce steam navigation, because there was only a barge canal; but it was not a narrow canal, and it had to be remembered that the cost of working a barge did not increase in the same ratio as the size of the vessel. The same crew would work 50 tons with the same ease as a smaller boat, and if there was sufficient depth, and a good sectional area, the same horses would do it. On the Bridgewater Canal they had something like 350 horses, and when they got the glanders amongst them, and about 150 had to be shot, he made up his mind to use steam, although the depth was only $3\frac{1}{2}$ or 4 feet. He put on 25 small steam tugs, and three 50-ton barges, which worked at a speed of $2\frac{1}{2}$ or 3 miles an

hour, with great regularity. The class of men who worked the horses on a towpath were fit for nothing else, and great delay aud difficulty was constantly arising, but on the steamboats they had a good class of men, who got a bonus for good behaviour, and they took great care that the three barges behind followed all right. The result was that the working expenses were reduced 40 per cent., and the company paid 8 per cent. dividend. The value of a canal to a country like England must not be judged merely by the amount of traffic carried; it lay in the competition. When Sir James Allport was asked in the Parliamentary Committee, when the Midland Railway was trying to buy the Worcester and Birmingham Canal, so as to control the traffic from the South Welsh ports to Birmingham, how it was that the traffic from the East Coast was not cheaper than from the South-West, he said there was the River Severn Navigation, and though it did not do a large traffic, if the Midland did not keep their rates down to the same point they would lose the trade. The canal they wished to purchase was the branch from the Severn to Birmingham, and on that evidence, of course, the case was gone. Sir Richard Moon, the late Chairman of the London and North-Western Railway, made a similar statement at a shareholders' meeting, when he was asked why, between certain points, the rates were different; he said presumably, in that case, there was water competition. The paper showed that every improvement in the main waterways of Germany had been followed by a large increase of traffic. That was what all our foreign competitors were doing, and Germany especially was our great competitor. He went into a shop the other day to buy some tools, and was offered some of German make, better finished than the English, and 30 per cent. cheaper. That was in a country town in Cheshire, and it showed how Germany was beating us. That class of goods, and many others, were of considerable weight, and the cost of carriage was important. France, Belgium, and other nations were giving every facility for cheap carriage. He saw in the *Times* that the German Emperor, in his speech at the opening of the Diet, referred to the subject of inland waterways, and said that a Bill would be submitted for the construction of canals connecting the Rhine and Elbe canals, and facilitating communication between the navigable rivers. The great value of this paper lay in the general considerations it put forward. They must build railways where speed was required, but canals could carry much more cheaply, there were no rails or sleepers required, they were more economical in working, and for slow traffic were preferable. It was difficult to say how the work should be done. It might be that it should be a national undertaking, as it was in America, France, Belgium, and Germany, where the Government assisted the canals the same as the railways. He agreed with Mr. Harcourt that it would not pay to improve small canals in agricultural districts, but only where there was heavy traffic, mineral or otherwise. Mr. Lloyd, of Birmingh[...] who took a great interest in this question [...] suggested a main canal joining the Severn, Birmi[...] ham, and Wolverhampton with the Mersey at Li[...] pool, and another from Birmingham to Lon[...] utilising the Grand Junction Canal. This wo[...] unite the main parts of the kingdom, and would t[...] very large extent meet the case.

Sir DOUGLAS GALTON, K.C.B., F.R.S., said [...] had been connected for many years with the Birmi[...] ham Canal, which had special difficulties in connect[...] with its construction and maintenance. There w[...] many parts which when he joined it first were [...] cuttings which were now on embankments of a co[...] siderable height, and there were in some pla[...] bridges which used to go over the canal which w[...] now standing 40 or 50 feet in the air above t[...] surface of the ground. That canal rested very larg[...] on the coal measures, which had been gradually tak[...] away and the ground had sunk, so the engineer h[...] had to keep the canal watertight whilst the rest of t[...] country had been sinking away from it. Mr. Jeb[...] therefore, deserved the greatest commendation for t[...] manner in which he had maintained that canal. In t[...] same way, as the locks were being perpetually pulled [...] pieces, Mr. Jebb devised a system of inclined plan[...] to supersede them in certain places, but Parliamenta[...] proceedings connected with the tolls, made t[...] directors consider it inexpedient to go on with t[...] scheme at the time. He agreed with the Chairm[...] that it was very desirable to have a canal from the se[...] or from the Manchester Ship Canal, perhaps to Bi[...] mingham on one side and to London on the othe[...] and he should also like to see it go to Bristol, whe[...] Birmingham would be in a very satisfactory positi[...] with regard to its inland trade. He had never hea[...] a paper on canals which treated so fully aud admirab[...] the whole subject of waterways, and the Society an[...] all England in fact, ought to be very grateful t[...] Mr. Harcourt for the trouble he had taken in pr[...] paring it.

Mr. L. B. WELLS said he had been interested i[...] canals for twenty years or more, having followed th[...] Chairman on the Weaver Navigation; and the wor[...] he initiated there had now been completed in th[...] main, the old style of lock having been recentl[...] cleared away by his successor, so that ships of 200 fe[...] length and 30 or 40 feet beam could now go to th[...] head of the salt district. He found only one of thos[...] large locks completed, and he himself completed fou[...] others; and in the meantime the river was bein[...] deepened. He found that whenever an addition[...] 6-inch draught was given, traders took advantage of it[...] and when facilities for an additional 5 feet length wer[...] afforded, many of the most enterprising lengthene[...] their vessels. The great point to be looked to wa[...] the cheapening of transport, for the charges wer[...] higher in England than in any other country in th[...] world. If we were to compete with other countrie[...] for the trade of the world, we must be able to transpor[...]

goods as cheaply as they did ; and as railways not compete in rates, all real competition could be obtained by an independent route, such as aterway. On a waterway any trader who thought could do better for himself than by employing a ier could have his own boat, and this was reat check on the charges. It did not pay yone to carry for themselves; but on the aver, where large tonnage was despatched by viduals or firms, they built their own boats, and ied their own salt from their works to the ships Liverpool. The Bridgewater, which was a very canal, as a barge canal, was vastly im-ved by the Chairman, when he adopted steam ead of horse traction. It served a coalfield in cashire much as the Weaver served the saltfield Cheshire. The Weaver had a depth of 10 feet, the tonnage carried to Liverpool and the Mersey two-thirds the whole output of the salt district, railways only taking one-third. The Bridgewater al took one-third the output of the coalfield, and railways two-thirds. That was a conclusive proof the advantage of large canals. The condition of ngs was well shown by the Table in which there e six squares at the bottom not filled up because e was no information available. It was extraordin- that a great commercial country should be content emain in such a state of ignorance. The idea was t as canals existed before the Board of Trade, the rd was afraid to press for information and returns, t did in the case of all new public enterprises, tramways, electric light companies, and so on. re had been only one return called for with pect to canals, and that was ten years ago. He eved a circular was issued at the beginning of this r, asking for further information, and he hoped t would produce further returns than had been ained heretofore. Seeing the attention paid to er communication in France and elsewhere, ough the traffic carried was much less than in gland, it was surely time that something should done at home at least to obtain full information.

Ir. MARTIN WOOD said it was ten years since the iety of Arts had a Conference on Inland Naviga-, and he was about to suggest that some steps uld be taken to ascertain and publish in the *rnal* the progress which had been made since , but the present paper had done that to a ain extent; though, as had been pointed out, e were no official statistics since that time. It a most valuable suggestion that the Board of de should be urged to fill up the gap; but a Royal nmission was almost a word of dread, and he ed some more efficient means might be devised bringing the subject before the minds of the lic and of responsible statesmen. The extra-inary negligence which had been displayed was l described in the paper. Of course there was a stant powerful, passive obstruction in the way, great railway interest, and the great popular feeling in favour of railways. It was therefore very important that such a paper as this should be published, and he hoped it would open the eyes of public men to the necessity of developing inland navigation, especially in view of the competition to which we were exposed by other countries.

Mr. HUBERT THOMAS, general manager to the Grand Junction Canal, said he had acted on one of the recommendations of the Board of Trade, viz., for amalgamation. After the inquiry of 1888 his company said they would adopt the suggestion then made, and amalgamate as far as possible the inland navigations with which they were concerned, viz., between London, Birmingham, Leicester, and the coalfields of Derbyshire. It had only been going on for a short time, but they had purchased two canals and entered into working arrangements with eight others, and were now in a position to quote a through toll for a distance of over 300 miles. That principle ought to be adopted in the north as well as the south; and if there were one or two great combinations, they could free themselves from railway control. A large trader came to him to know if he could arrange for his traffic from Manchester to London, and he said he could. He was paying a fabulous sum by rail, and he had no doubt that if the arrangement was carried out, as he hoped it would be, that traffic would be carried for one-fourth what was now paid. The person referred to said if he once put his goods on the canal he should keep them there; but unfortunately the experience of canal managers was that the canal was simply used as a lever to keep down the railway rates. If it were not for the canals, the rate for the carriage of coal to London would be 8s., 9s., or 10s. a ton. He did not agree with one part of the paper, where, as he understood, the author said there would be little advantage in widening long sections of inland navigation, because that was exactly what his company were doing for some 150 to 200 miles, where there was no great centre of traffic; this, however, would enable them to connect London and the coalfields, so that barges of 60 or 80 tons could come straight through.

The CHAIRMAN said he thought Mr. Harcourt was only referring to agricultural traffic in the passage to which Mr. Thomas had alluded. It was quite true that the canals did not get their fair share of the traffic. They did an enormous good to the public in keeping down heavy rates, and the least the public could do was to put more traffic on them. He begged to move a cordial vote of thanks to Mr. Vernon-Harcourt for his paper.

The vote of thanks having been carried unanimously,

Mr. VERNON - HARCOURT, after expressing his gratitude to the meeting for the vote of thanks, said he thought that if Mr. Thomas would examine the paper

he would find that they were entirely in accord. The Grand Junction was one of the canals which he had drawn attention to as a proper one to be improved. Those which he thought it would not pay to improve, were some of those in the south where there was no bulky traffic to be carried, such as coal or other minerals, and large merchandise.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

JANUARY 25.—"Tuberculosis in Animals." By W. HUNTING. R. BRUDENELL CARTER, F.R.C.S., will preside.

FEBRUARY 1.—"The Cost of Municipal Enterprise." By DIXON H. DAVIES. The ATTORNEY-GENERAL will preside.

FEBRUARY 8.—"Nernst's Electric Lamp." By JAMES SWINBURNE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

FEBRUARY 9.—"The Penal System at the Andamans." By Colonel RICHARD CARNAC TEMPLE, C.I.E., Chief Commissioner of the Andaman Islands. The EARL OF NORTHBROOK, G.S.I., D.C.L., F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

JANUARY 24.—"Rhodesia and its Mines in 1898." By WILLIAM FISCHER WILKINSON, F.G.S., Assoc. M.Inst.C.E. The Hon. Sir DAVID TENNANT, K.C.M.G., Agent-General for Cape Colony, will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

JANUARY 31.—"The Centenary Exhibition of Lithographs, with remarks on further Developments of the Art." By EDWARD F. STRANGE. Major-Gen. Sir JOHN DONNELLY, K.C.B., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

LECTURE II.—JANUARY 23.

Recognition of the function of bacteria, and researches on them—Massachusetts, Barking, and Sutton experiments—Schemes for aeration: Lowcock, Waring, Ducat—Materials—Garfield's coal filter—Manchester and Leeds experiments.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Samuel Rideal, "Bacterial Purification of Sewage." (Lecture II.)

Imperial Institute, South Kensington, 8½ p.m. Mr. E. T. Scammell, "The Work and Wea[lth] o[f] Western Australia."

Surveyors, Savoy-street, W.C., 8 p.m. Mr. E[dwa]rd Boyle, "Rating of Collieries."

Geographical, University of London, Burlin[gto]n-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Presidental address to students, and presen[tati]on of prizes.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Shelford Bidwell, "Optical Illusions."

TUESDAY, JAN. 24...SOCIETY OF ARTS, John-s[tre]et, Adelphi, W.C., 4½ p.m. (Foreign and Co[lon]ial Section.) Mr. William Fischer Wilkinson, "[Rh]odesia and its Mines in 1898."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "The Morphology [of t]he Mollusca." (Lecture II.)

Medical and Chirurgical, 20, Hanover-s[qua]re, 8½ p.m.

Civil Engineers, 25, Great George-street, S.[W.,] 8 p.m. Discussion on papers by Mr. Willia[m G.] Kirkaldy, "The Effects of Wear upon Steel R[ails,]" and Sir William Roberts-Austen, "The M[icro]-Photography of Steel Rails."

Photographic, 12, Hanover-square, W., 8 p.m. Technical Meeting. Mr. John Sterry, "Th[e D]e-velopment of Gelatino-Chloride Papers."

Anthropological, 3, Hanover-square, W., 8½ p.m. Annual Meeting.

WEDNESDAY, JAN. 25...SOCIETY OF ARTS, John-s[tre]et, Adelphi, W.C., 8 p.m. Mr. W. Hunting, "T[ube]r-culosis in Animals."

Japan Society, 20, Hanover-square, W., 8½ p.m. Conversazione.

British Astronomical, Sion College, Vict[ori]a-embankment, W.C., 5 p.m.

THURSDAY, JAN. 26...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. F. W. Sawyer, "Our National Songs."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. H. Savage Landor, "Tibet and [th]e Tibetans." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. J. Pegg, "Rules for the Regul[atio]n of the Wiring of Premises for Connecti[on] to Public Supply Mains." 2. Mr. C. H. Wor[drin]g-ham, "The Regulation of Wiring Rules." 3. Mr. R. E. Crompton, "The Institution W[irin]g Rules."

FRIDAY, JAN. 27...Royal Institution, Abemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Sir M[oun]t-stuart E. Grant Duff, "Epitaphs."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. F. C. Gri[ffi]th, "King's Lynn Water Works."

Junior Engineering, Westminster Palace H[otel], S.W., 8 p.m. Prof. J. A. Ewing, "Mea[sure]-ments of Elasticity."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlin[gto]n-house, W., 5 p.m.

SATURDAY, JAN. 28...Botanic, Inner Circle, Regent's-[Par]k, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 5 [p.m.] Sir Alexander Mackenzie, "Tschaikowski," ([wi]th musical illustrations.)

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FRIDAY, JANUARY 27, 1899.

All communications for the Society should be addressed the Secretary, John-street, Adelphi, London, W.C.

Notices.

SWINEY PRIZE.

A meeting of the adjudicators of this prize, ppointed by the will of the late Dr. Swiney, vas held on Friday, January 20, 1899, at the Society of Arts, at 4 p.m., Sir John Wolfe Barry, K.C.B., Chairman of the Council, in he chair.

The Secretary read the advertisement con- ening the meeting.

The Secretary read a report from the joint Committee of the Society of Arts and the College of Physicians, recommending that the rize should be awarded to Dr. J. Dixon Iann, for his work entitled "Forensic Medi- ine and Toxicology."

It was thereupon moved by Sir John Wolfe arry, seconded by Dr. Cheadle, Senior Censor f the College of Physicians, and resolved, That the prize, a silver goblet value £100, ontaining gold coin to the same amount, be djudged to Dr. J. Dixon Mann, F.R.C.P., rofessor of Forensic Medicine and Toxicology Owens College, Manchester, the author of a ublished work on 'Forensic Medicine and oxicology.'"

The cup has been executed by Messrs. arrard, from a design made for the Society the late Daniel Maclise, R.A.

CANTOR LECTURES.

Dr. Samuel Rideal delivered the second cture of his course on "Bacterial Purification Sewage," on Monday evening, 23rd inst.

The lectures will be printed in the *Journal* ring the summer recess.

OREIGN & COLONIAL SECTION.

Tuesday afternoon, January 24th, 1899.; e Hon. Sir David Tennant, Agent- eneral for Cape Colony, in the chair.

The paper read was "Rhodesia and its Mines in 1898," by William Fischer Wilkinson, F.R.G.S., Assoc. M.Inst. C.E.

The paper and report of the discussion will be printed in the next number of the *Journal.*

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Thursday afternoon, January 19, 1899; Sir Alexander Mackenzie, K.C.S.I., in the chair.

The paper read was—

RAILWAYS IN BURMA, AND THEIR PROPOSED EXTENSION ACROSS YUNNAN.

By John Nisbet, D.Oec.,
Conservator of Forests, Burma.

When considered as to ultimate effects, there is probably no question of foreign policy which at present more closely touches the commercial interests of Great Britain than the series of problems gradually solving themselves in China. Whether the Chinese Empire continue to remain more or less consolidated, even though honeycombed by "spheres of influence," or whether it be ultimately partitioned into territories actually under the dominion of Russia, Germany, France, Japan, and Great Britain, there can be no doubt that British interests in China at the present moment bulk largest in every way.

The study, unbiassed by any political prejudice, of the numerous articles which have recently appeared with regard to China and Chinese trade in all of the leading reviews—articles of praise, of censure, and of exhor-

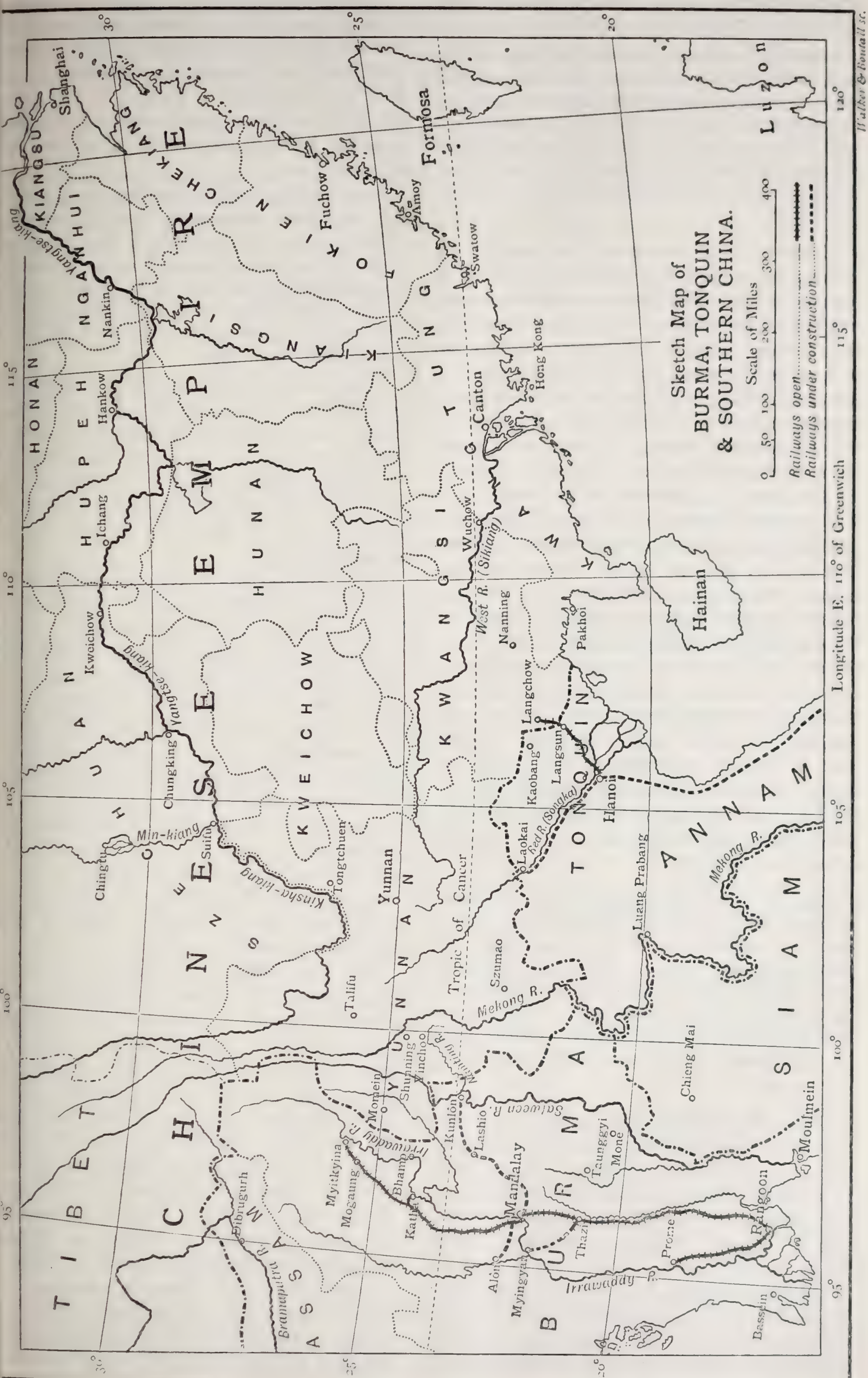
tation — will show that, within reasonable limits, the Government of the day have been fully alive to the political and commercial interests of Britain in the Far East, and that they have amply paved the way for the further development of these interests. This being the case, it is gratifying to find that commercial bodies and industrial syndicates are now energetically bestirring themselves, and taking the necessary steps to push their own individual or collective interests. The onus of further action rests mainly with them, and not merely with our diplomatists.

As the object of the present paper is to deal more particularly with the proposal to extend the railway now under construction from Mandalay to the Salween River so as to push it on further eastwards to tap the trade of Yunnan—presuming that there is any trade really worth tapping—and perhaps even to reach an objective point on the Yangtse-kiang whence steam communication to and from Shanghai may ultimately be possible, it is hardly necessary to consider the present political position in the Far East of any other rival European power except France in connection with this special phase of the China question.

The Yangtse drainage comprises the rich provinces of Kiangsu, Nganhui, Kiangsi, Hupeh, Hunan, Szechuan, and the northern portions of Kweichow and Yunnan, the trade to and from all of which must naturally proceed by way of the Yangtse-kiang. If the supremacy of British interests in this sphere, the most important part of China, were to be threatened, as some have predicted, by France endeavouring from the south to join hands with Russia from the north with a view to excluding the British from the Yangtse Valley, this might, and in all probability would, necessitate the valley being formally assigned to us as a recognised "sphere of influence," or it might even lead to a British protectorate being formed there. We hear much of the "open door" policy. It must, however, be clearly understood that we require not only such an open door but also a through passage from Shanghai and Hongkong to Assam and Burma. So far as British commerce in the main portion of the Yangtse Valley is concerned, the natural lines of transport all converge towards Shanghai, and the trade capable of development in that sphere could never profitably find its way out through Burma; while the promise extended to France with regard to the three southern provinces (Kwantung, Kwangsi, and Yunnan) marching with French Indo-China, is very far from being equivalent to granting that empire the sole right of trading there. At the same time we shall indeed be blind to the lessons learned during the past decade and a half if we do not carefully watch the action of our French neighbours, our political and commercial rivals in south-western China.

The recent railway reconnaissance survey by French officials from Kwangtung through Hunan to Hankow, referred to in the *Nineteenth Century* for September, 1898 (page 389) shows how essential vigilance and a definite attitude are. And if there is any real political danger from such causes, then the simplest and cheapest method of frustrating unfriendly intentions is obviously to be beforehand in enterprise. The attainment of this end would probably be assisted by the commercial occupation of all essential points by means of increasing the number of British consuls. Between the present consular posts of Chungking, in Szechuan, and those of Momein and Szumao, in Yunnan, the distance is about 600 miles. The diplomacy which early in the present year obtained from China the indirect and informal guarantee against cession of any portion of the Yangtse Valley to any foreign power and the right to construct a railway from the Burmese frontier to that valley, should, if necessary, be able to obtain the privilege of posting consuls and allowing British subjects to establish themselves and to trade at important points further west, such as Suifu, Chingtufu, Tongtchuenfu, and Talifu. In addition to the consuls at Momein and Szumao, the only other resident British officials now on that Chinese frontier are the subalterns in charge of detachments of the Burma military police force stationed at Sima and Sadôn, between Momein and Myitkyina and at Satisu, about forty miles to the north-east of the Kunlôn ferry on the Salween river.

The natural outlet for trade throughout practically the whole of the Yangtse Valley is, as already stated, eastwards towards the coast. Even under the most favourable circumstances it would be only a small and comparatively insignificant portion of its commerce which could be profitably diverted towards Burma. With the Yangtse navigable for 2,000 miles as to its main branch, and for another 1,000 miles as regards its chief affluents, there seems little chance of any important deflection of trade from this natural outlet towards Shanghai. Mr. Little's evidence is very clear on this


Sketch Map of
BURMA, TONQUIN
& SOUTHERN CHINA.
Scale of Miles
0 50 100 200 300 400
Railways open
Railways under construction
Longitude E. 110° of Greenwich
CHINESE EMPIRE
TIBET
ASSAM
BURMA
SIAM
ANNAM
TONQUIN
Luzon
Formosa
Hainan
KIANGSU
NGANHUI
CHEKIANG
FOKIEN
KIANGSI
HONAN
HUPEH
HUNAN
KWANGTUNG
KWANGSI
KWEICHOW
SZECHUEN
YUNNAN
Shanghai
Nankin
Hankow
Ichang
Kweichow
Chungking
Chingtu
Suifu
Fuchow
Amoy
Swatow
Canton
Hong Kong
Wuchow
Nanning
Pakhoi
Langchow
Kaobang
Langsun
Hanoi
Laokai
Luang Prabang
Tongtchuen
Yunnan
Talifu
Szumao
Chieng Mai
Moulmein
Rangoon
Bassein
Prome
Thazi
Mandalay
Taunggyi
Mone
Lashio
Kunlon
Momein
Shunning
Yinchoo
Bhamo
Katha
Myitkyina
Mogaung
Alon
Myingyan
Dibrugurh
Yangtse-kiang
Min-kiang
Kinsha-kiang
West R. (Sikiang)
Red R. (Songka)
Mekong R.
Salween R.
Irrawaddy R.
Brahmaputra R.
Tropic of Cancer
Walker & Boutall sc.

point, as given in the *Contemporary Review* for September, 1898 (page 366) :—

"Szechuan is a land apart; and, although tedious land roads, literally footpaths, climb by wearying staircases over the wall in other directions, giving it communication with Pekin, to the north-east, and with Talifu, the great city of the Yunnan province in the south-west, yet the only really serviceable communication with the outside world is by way of the Great River."

Moreover, this description can equally well be applied, so far as the mule and cattle tracks are concerned, to the trade routes leading westwards from the province. What trade there is on the Yunnan plateau, which varies from 5,000 to 8,000 feet in elevation, and whose capital is Yunnanfu, though by far its most important trading centre is Talifu, may very possibly find its way into Burma. It probably already does so, even without any expensive railway. So far as concerns the bulk of the traffic that will interest Europeans, however, this must naturally proceed eastwards down the Yangtse-kiang. Mr. Bourne, of the Blackburn Commercial Mission, has shown that the first step towards tapping this trade is not a railway, but the extension of steam navigation on the Great River from Ichang to Chungking and thence to Suifu, 1,700 miles from Shanghai. Towards this end the recent promise of China to open the rivers to trade and to establish a treaty port in Hunan is a distinct step, while the following Reuter's telegram, despatched from Pekin on 14th January, and appearing in all the London papers three days ago, seems full of hope and promise :—

"Mr. Liverkaye, representing a British Syndicate, has proposed to survey the Yangtse Gorges with a view to removing obstructions to navigation. At present navigation between Ichang and Chungking is slow. Several attempts have already been made by the Chinese to effect an improvement. The proposal, if realised, will confer an enormous advantage on British commerce. Repayment will be effected by tonnage tolls."

These are obviously sound commercial proposals which are already receiving consideration, and which are certain to be seriously entertained as soon as ever merchants obtain something in the shape of guarantees respecting the capital involved in extensive investments of this nature. Obviously to give or to obtain such guarantees is equally the duty of the British Government in the interests of British commerce. The recent loan to China of £12,000,000 at 3 per cent. is, strengthened by the conditions attached to it, in itself almo of the nature of an informal guarantee th British commercial interests in the Yangt Valley will be adequately safeguarded by t British Government. Viewed in this ligh Mr. Little's further information is here aga of great interest and worthy of serious co sideration :—

"It is no exaggeration to say that, given a stal and progressive Government, affording encoura ment to capitalists with security for their investme —resulting in improved means of communication a a corresponding development of its natural resour —the Yangtse Valley will increase its trade by le and bounds, and the £30,000,000 of to-day will £300,000,000 to-morrow."

If this statement be correct, or if mercant men can see any probability of their positi being sound, British capitalists can surely trusted to step in and make their profita investments without much fear of French co petition in districts far distant from the Fren base situated to the south of the Nanli mountain range.

There seems to be no doubt that Chungki —"the great commercial metropolis of t West. Estimated population 400,000" (Littl "Through the Yangtse Gorges," 1898, pa 134), distant about 500 miles in a straight li north-east from Talifu—is the proper poi from which Anglo-Chinese railways shou be constructed so as to radiate througho Szechuan and Kweichow, and perhaps ultimate to become connected with the Burma railw system at the Kunlôn ferry at least 300 mil distant by road or rail. The census of 18 showed the population of Rangoon to 180,324, and of Mandalay to be 188,815; hen Chungking vastly exceeds either of the important towns in population.

The first definite proposals for a railw from Burma into Western China were tho formulated by Mr. Colquhoun after his journ "Across Chryse," from Canton to Bhamo, 1882, and by Mr. Hallett in 1884, on his co pleting a personal reconnaissance. Mr. Hall advocated the construction of a railway sta ing from Moulmein, the seaport at the mou of the Salween River in the Tenasserim provin of Lower Burma, and proceeding by way Zimmè (Chieng Mai), in Siam, northwards the Mekong Valley to Szumao, in Yunna and possibly capable of extension to Talifu.

Apart from any financial questions, t political circumstances in Burma, Siam, a Tonquin, have altered so vastly in the meanti that such a project can never again be serious

mentioned. A much less ambitious proposal is one for a line from Moulmein, down the Meinam Valley to Bangkok, the capital of Siam, which would bring important advantages to both countries.

So far as the trade of the south-eastern portion of the province of Yunnan is concerned, consideration of the geographical and physical features of the country seems to indicate that the natural lines of export are either down the West River (Sikiang) to Canton and Hongkong, or else following the Red River (Songka) to Hanoi, the capital of the French possessions in Tonquin. The French maintain that in the latter route they have solid advantages. They are certainly nearer to the tracts to be tapped; but the commercial advantages gained by China's agreement of June, 1896, to throw open the West River to foreign trade as far as Wuchowfu, may tend to equalise the possibilities between Hongkong and Hanoi. In any case, however, the commerce throughout by far the greater portions of the provinces of Kwangsi and Kwangtung, must proceed down the valley of the Sikiang to Canton and Hongkong. If the trade of South-Eastern Yunnan find its natural outlet through Tonquin, and even if, in addition thereto, a considerable share of the Western Kwangsi trade be attracted towards the French railway now being pushed on from Hanoi, in the direction of Nanningfu about 200 miles to the north-east—the great trade centre on the Yu River, the main southern tributary of the Sikiang—there still remains an ample and promising field for commercial energy radiating from Hongkong and Canton. Just as has already happened in the case of Chungking and the Upper Yangtse Valley, so also will trading developments or other considerations in due time lead to the extension of the agreement of June, 1897, and gradually include the upper portions of the West River.

Now, what have our French neighbours done in the way of railway construction in Tonquin, and what projects appeal most directly to them in the immediate future? The Tonquin railway running north-east from Hanoi to Langsun, begun in 1890, has been extended northwards to Langchow, within the borders of Kwangsi. Endeavours will perhaps be made to push it on towards Yunnan, by way of Kaobang, though it seems more probable that it will first be extended north-east to Taiping and Nanningfu (about 100 miles), and thence to Sienkiang (about 150 miles), or else to Sinchow, or to the treaty port of Wuchow on the West River. From Nanningfu a branch will extend to the seaport of Pakhoi. It was strongly urged by M. de Lanessan, ex-Governor-General of Tonquin, in his book "La Colonisation Française en Indo-Chine," 1895 (pp. 327-329), that priority in railway construction should be given to extending the Langchow-Hanoi line to the south of the Red River delta, and thence, following the hill-slopes of Annam and the coast line, to Saigon. On the completion of this main line he then recommended that the railway next in importance was a branch running north-westwards from Laokai, on the borders of Yunnan, to receive the trade of the southern part of that province.

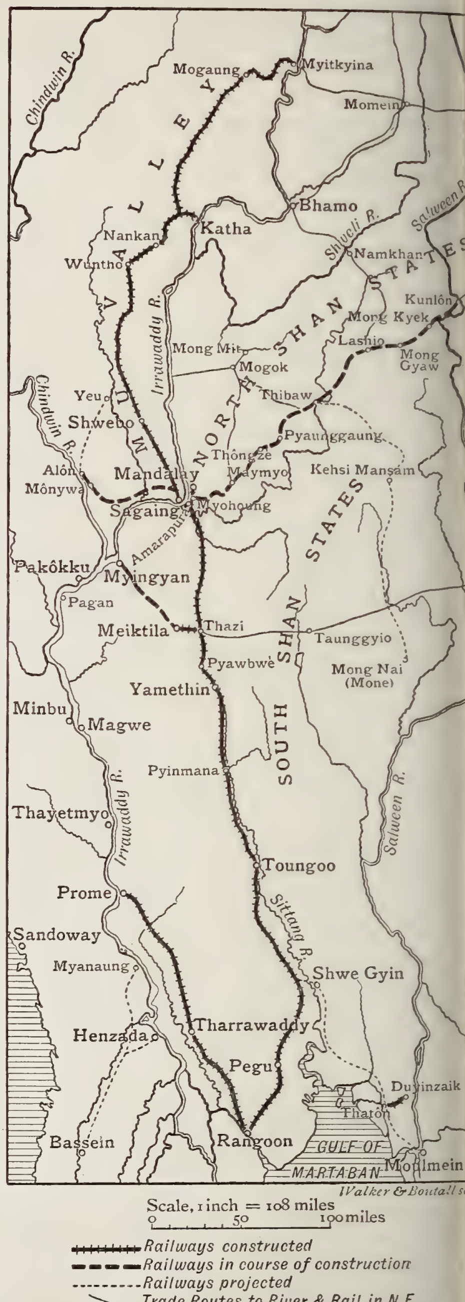
On 8th December, 1898, the Colonial Committee of the French Chamber finally agreed, on M. de Lanessan's report, to guarantee 70,000,000 francs (£2,800,000) for the line from Hanoi *viâ* Laokai to the frontier of Yunnan, and thence into Yunnan. And on the 15th December the Chamber "almost unanimously" adopted the Bill for a loan of 200,000,000 francs (£8,000,000) for the construction of other railways guaranteed by the Government of Indo-China. The chief projects covered by this latter grant are a coast line in the direction of Annam, and a line terminating in Cochin China. The reasons and arguments used by M. de Lanessan in advocating the extension of the Hanoi-Laokai line into Yunnan will be found in detail in the *Rappel* of 22nd December, 1898. Taking a comprehensive and liberal view of affairs, Britain can well give her best wishes to a French line from South-Eastern Yunnan down the Red River to Tonquin, provided Britain secures possession of all trade routes trending S.W., W., or N.W. through Talifu or other northern tracts into Burma and Assam.

Previous to the Panthay or Mohammedan insurrection of 1854, in Yunnan, when the population is supposed to have been reduced from something between 10,000,000 and 15,000,000 to about 5,000,000, the commerce of this highland region is reported to have been extensive and valuable. The present population is variously estimated at from 5,000,000 to upwards of 11,000,000, and some assert that it is quite as large now as ever it was. The main lines of export are northwards into the Yangtse Valley, eastwards down the West River, southwards into Siam and the Shan States, and westwards into Burma. French activity must naturally attract towards Hanoi a certain proportion of the trade that now exists or that may be capable of being developed.

Even if such attraction amounted actually to deflection it would not be of much consequence were it not that British commerce is handicapped against French trade by heavy import duties in Tonquin. But it is by no means certain that the possibilities of South-Eastern Yunnan have not been much exaggerated; while the opening up of the West River will help that route to recover at any rate some share of the prosperity it is alleged to have formerly enjoyed. In any case, the commerce of South-Eastern Yunnan is little likely to be affected by the proposed railway line from Burma into China.

The railways in Burma are all of metre gauge. They consist of two main trunk lines of very unequal length, both of which were originally State railways. That constructed first and opened to traffic in 1877, the Irrawaddy Valley State Railway, runs from Rangoon, the capital and the chief seaport of Burma, situated near the mouth of the Irrawaddy River, north-west; for 163 miles to Prome, an important town on the left bank of the Irrawaddy. Throughout most of its length the railway follows the military road constructed at the close of the second Burmese war (1852-53) to connect Rangoon with the old frontier station of Thayetmyo, 45 miles north of Prome. This line passes through rich ricefields, and has all along been a remunerative investment. Apart from the strategical objects which were of considerable influence in determining the Government of India on its construction, it has contributed in a very marked degree to the spread of rice cultivation and the increase of revenue throughout the Hanthawaddy, Tharrawaddy, and Prome districts. Where 25 years ago in Tharrawaddy there were vast compact areas of tree forest only broken into here and there by patches of permanent cultivation, there are now enormous stretches of rice lands; while the area still under forest on the plains has been reduced to far lower proportions than are desirable in the interests of agriculture. Fortunately the summer rains brought by the south-west monsoon never fail throughout the central and southern portion of the districts traversed by the railway, so that anything like a famine consequent on excessive clearance of the primeval forest need not be feared. The only tracts that still remain uncleared for rice cultivation within easy reach of the line of railway are areas reserved as State forests for fuel and fodder or as grazing grounds set apart for the plough cattle.

After the completion of this first short line, the survey was put in hand of a similar line o[f] about equal length (166 miles) running north b[y] east through the Pegu and Shwegyin district[s] to Toungoo, the other old frontier militar[y]



station on the Sittang River. The prospect[s] of this Sittang Valley State Railway payin[g] as well as the line on the Prome side were no[t] so promising at first; but strategical reason[s]

re far stronger in this than in the previous se. From Rangoon to Prome and Thayetmyo ere had always been good river communica-on by means of the Irrawaddy Flotilla Com-ny's steamers, whereas the troops in Toungoo re much more out of touch with the central litary authorities. Toungoo could, it is true, reached either by land or water. But the nd route involved marching for more than 160 les over a very bad road crossed by several rge streams, some of the largest of which re neither bridged nor served by ferries. oreover, only the first 50 miles or so of the ad were metalled, and very badly metalled o, so that this route was only practicable tween the months of November to April. ne river communication was equally bad. ne passage from the Pegu River to the Sit-ng, and consequently the ascent of the latter, uld only be made during the fortnightly ring tides, at which periods the strong bore shing up the winefiller-shaped mouth of the ttang river was sometimes dangerous. The cent by river from Rangoon usually took om 10 to 20 days, in great discomfort, and it as all but impracticable during the flood ason lasting from June to October. For at at time, prior to 1884, there were few steam unches in Rangoon, and the conveyance of oops and of other travellers took place in ats roofed in with a thin low awning of atch. It was uncomfortable to have to lie wn all day long, and day after day, on the rd boards of a so-called Chittagong boat, d a relief to be able to get out and walk up d down a sandbank while the evening meal as being cooked. All movements of trade tween Rangoon and the Sittang River were ewise limited to the high tides recurring tnightly, as at other times the Kyasu creek, ding from the Pegu River across into the tang, was blocked for want of water. Such s the rather unpleasant state of affairs until e opening of the Sittang Valley State Rail-y in 1884.

Permanent cultivation near this new line of lway soon began to extend, though nothing e so rapidly as had been the case in the less nly populated tracts traversed by the Prome e. The Sittang Railway had, however, this eat advantage, that it was capable of exten-n northwards to Mandalay whenever circum-nces might render such a scheme feasible. at this opportunity was actually forced upon mainly through the action of the French, now a matter of history. The annexation of pper Burma on 1st January, 1886, and the military operations entailed thereafter in the occupation and the pacification of the new terri-tories, necessitated the extension of the Sittang line to Mandalay. The work of survey and of construction was carried on in tracts that were most seriously disturbed by predatory bands of "dacoits" or gang robbers; and it is perhaps the finest achievement of our civilisation in Burma that this extension, measuring 220 miles from Toungoo to Mandalay, was opened to traffic early in 1889, within $3\frac{1}{4}$ years of the annexation of Upper Burma. This will ever remain an honourable monument of Sir Charles Bernard's administration of Burma during the troublous years immediately following upon the announcement of annexation: for it was mainly through his personal insistence that the exten-sion scheme was somewhat reluctantly ap-proved by the Government of India.

One of the results of this through railway communication between the moist tracts of Lower Burma and the central dry zone of Upper Burma — in which, owing mainly to excessive clearance of the original forest covering, the humidity of the atmosphere is very low and the storage capacity of the soil for retaining moisture has been ruined, while the surface-soil is easily eroded and washed away during heavy rainfall—has been that in years of scarcity, such as have been of frequent recurrence recently, large supplies of rice and other foodstuffs can be poured into the afflicted districts. At the same time the people can easily, if they like, be transferred by rail to the vicinity of tracts not far distant in Lower Burma, where danger from drought does not exist, and where good land can still readily be obtained from Government for clear-ance and permanent occupation on uncom-monly easy terms.

On the completion of the line to Mandalay, a survey was almost immediately put in hand for opening up the new province by extend-ing the railway system northwards towards Shwebo, and then beyond that to Katha, to Mogaung, and to the upper portion of the Irrawaddy River, about 100 miles north of Bhamo. The Myohaung, or "old metropolis" station, a few miles south of Mandalay, was chosen as the most convenient point of junc-tion, and from this a short branch was thrown out westwards to Amarapura. Here the Irra-waddy has to be crossed in large and power-ful ferry steamers to the town of Sagaing, whence the Mu Valley State Railway was constructed running northwards through the Sagaing, Shwebo, Katha and Bhamo districts.

to Mogaung and Myitkyina. In its course through Shwebo and Katha it passes within 12 miles of the Wuntho goldfields, from which so much was expected and so little has up to date been obtained, mainly owing to the want of liberality in the existing mining regulations. This railway was opened to traffic in sections, first of all to Shwebo in 1893, then to Katha on the Irrawaddy, which is connected with the main-line by a short branch, in 1895, then to Mogaung in 1897, and now to Myitkyina during the autumn of 1898.

This line gives a great deal of trouble at one particular point in the Katha district where it passes through the Nankan gorge of the The stream. In 1897 there was a bad landslip which dislocated even light traffic so much that passengers had to walk across the breach to a train on the other side. On 24th and 25th September, 1898, there was very heavy rainfall which flooded the stream and destroyed the railway line in the gorge, making far worse breaches than had ever previously occurred. Even in December, 1898, the breaches were not yet completely repaired, and only one train a day was then being run.

Myitkyina, the head-quarters of a new district of the same name, is the terminus of the railway line up the Irrawaddy Valley, at a point 724 miles distant from Rangoon by railway and about 1,000 miles by river. It is situated on the right bank of the river, about 25 miles below where the two branches, the Malika and the Meika unite to form the Irrawaddy. At Myitkyina, and for about 12 miles further north, the river is navigable for steam launches; but beyond that steam navigation is and must remain impracticable. From December till May steam launches can run between Bhamo and Myitkyina, but not during the rainy season from June till the end of November; for in the gorge known as "the first defile" the floods, rising over 80 feet high and pent up till they pour over a narrow opening called "the Pashaw's gate," render navigation either up or down stream equally impossible. Even in the dry season there are stringent regulations as to the departure of launches upwards from Bhamo and downwards from Sinbo, in order to obviate casualties in the defile. Under no circumstances could large steamers make the journey at any time of the year; and whatever traffic there is, or there ever will be, the requirements of commerce are far better served by the railway than they possibly could be by river steamers runni[ng] between Bhamo and Myitkyina.

From Wuntho northwards the line pass[es] through thinly-populated districts which a[re] certain to be more extensively cultivated la[ter] on. To the north and east, Myitkyina is sh[ut] in by lofty hills, thickly wooded and sparse[ly] inhabited by wild jungle tribes. Any r[e]munerative extension of this main line beyo[nd] Myitkyina is, therefore, hardly to be thoug[ht] of in the meantime, though a branch fr[om] Mogaung northwards, by way of Kamain[g] up the Hukong Valley to connect with t[he] Assam railway system has been conside[red] so far as to have been the object of a rec[on]naissance survey during 1895-96. The resu[lts] were, however, not sufficiently encouragi[ng] to hold out any hope that the project can [at] the present be considered remunerative. T[his] is, however, a scheme much more worthy [of] consideration by British capitalists than [a] railway into Yunnan.

After the opening of the Mu Valley Railwa[y] the various lines were amalgamated a[nd] called the Burma State Railways; but t[he] name was altered when the Burma Railwa[ys] Company, Limited, took over all the existi[ng] lines and projects on the 1st September, 18[..]. This company, formed in July, 1896, contrac[ted] to take over from the Secretary of State [for] India the open system of railways in Bur[ma], then aggregating 834 miles in length, a[nd] to complete and eventually work other lines [in] progress, amounting to 360 miles more—[or] about 1,200 miles in all—and to construct a[nd] work such other lines as the Secretary [of] State may think fit to entrust to it, Gove[rn]ment arranging to contribute further capi[tal] or enabling the company to raise the sa[me]. The capital is £2,000,000, of which half [is] been called up and on which the Ind[ian] Government guarantee a dividend of 2½ [per] cent. per annum together with one-fifth [of] the surplus earnings beyond that interest. [It] was also guaranteed that this one-fifth sho[uld] not be less than ¼ per cent. for the first [five] years ending with June, 1901. Provisions w[ere] likewise made in the contract as to the util[iza]tion of the net earnings for discharg[ing] interest on any debentures raised, and for p[ay]ing to Government interest at 2½ per cent. [per] annum on the capital expended in construc[tin]g the railways. Further, Government reser[ved] the right of determining the contract at [six] months' notice in 1921, or in any tenth y[ear] thereafter, or in the event of the undertak[ing] not paying its expenses for three succes[sive]

lf-years. In the event of such determina-
n, the share capital is to be repaid at par. hat is to say, the onus of finding money for l constructions within British territory really lls on the Government of India, whose nancial position does not justify their rushing to rash expenditure. Beyond that, for rveys and other charges in Yunnan the overnment of India can have no responsibility.

The present status of the Burma railways is us clear and definite. The company not ly took over the active management of the isting open lines of railway, the lines in urse of construction, and the projects under nsideration, but they also voluntarily incurred e liability to construct further extensions dered by the Government of India on the arantee from the latter of an uncommonly w rate of interest for investments of the ture in question in a country like Burma.

The principal line in course of construction is e branch extending from Myohaung, near andalay, which is also the junction for e Mu Valley section to Mogaung and yitkyina, eastwards through the Northern an States by way of Maymyo (the new hill-station" of Burma), Thibaw and Lashio bout 170 miles distant) to some point within asonable touch of the Kunlôn ferry on the lween river. These facts being fully under-
od and appreciated, the question of extend-
g the line thence by some as yet unsurveyed gnment into South-Western Yunnan and on-
rds, so as ultimately to reach some objective int on the Yangtse river, can now be viewed its political and commercial aspects.

The Anglo-Chinese agreement of June, 1897, rticle XII.) provided for the construction of lways in Yunnan being considered, in the ent of trade conditions justifying this, and such railways being connected with the rmese lines. This concession, coupled with right of posting consuls at Momein and amao, had long been desired by commercial n in Britain, whose knowledge of Burma, the Shan States, and of Yunnan was and is personal but mostly hearsay. These im-
rtant concessions have of course aroused nmercial feeling, both in China and in Eng-
d, and are very naturally being used for the rpose of bringing political pressure to bear on British Cabinet so as to compel the latter to e steps of some sort in the name of com-
rce. The London daily press simply teems h examples of pressure thus being brought to r on the Foreign Office. And what is the sition of the British Cabinet in an affair of this sort? No matter whether a Conservative, a Liberal, or a Radical Government be in power, the British Cabinet is subject to Newton's first law of motion: it remains in a state of rest or of uniform motion in the straight line of its own party policy, except in so far as acted on by extraneous forces. These impelling forces are twofold in their nature. They may be either the political and commercial acts of foreign Powers, or they may be the resultant of manifestations of public opinion throughout Britain and the British Empire. Unfortunately, when the action of either or both of these extraneous forces becomes manifest in the foreign policy of the British Cabinet, it must usually happen that the energy then displayed exerts itself too late to reap the full political and commercial advantages that might other-
wise have been obtainable. Public opinion should be, and is being, educated to join forces with the efforts of commercial men in order to break down through British influence the barriers that exist to the progress of free trade and of civilisation throughout nearly the whole of the Chinese empire. Several commercial syndicates are already taking active steps by sending out small survey parties to make special investigations and to collect information of all sorts required before the Chinese and the British Governments can reasonably be approached with definite requests for concessions or guaran-
tees. Public opinion will be unanimous in approving such enterprise and in wishing it success. At least three different parties are now already engaged in, or are about to com-
mence, commercial and engineering investiga-
tions in Yunnan and the Yangtse valley. Two of these, working in the same interests, will concern themselves with the exploration of Yunnan, one party ascending from the Burma side and the other from the Yangtse river. When both parties join hands at Talifu or elsewhere, as is hoped will be the case in March or April next, the results of the expeditions will be worked out by Captain Davies, of the Oxford-
shire Regiment and of the Army Intelligence branch, who is in charge of the party from Burma, and whose work in his own special de-
partment is so favourably known. No selection could have been better, and the results of the investigations of Captain Davies's expedition, which is accompanied by a young engineer officer, will be awaited with full assurance that they will be well conducted. Public opinion will here again be unanimous in approving the loan by Government of their officers for com-
mercial enterprises of this adventurous and

energetic nature. But it is to be regretted that these various syndicates do not co-operate instead of remaining as separate mercantile interests. Union is strength: and no nation appreciates the advantages of co-operation more intelligently than the Chinese, or knows better how to trifle with divided interests of this sort.

If matters advance beyond these preliminary steps undertaken by merchant adventurers of the City of London, then all further negotiations regarding concessions and guarantees must in equity be guaranteed by the British Government; otherwise, to involve the Government of India in such a matter will be adding yet another to the many financial wrongs already done to India in the name of Imperial requirements. The Secretary of State may indeed bring pressure to bear on the Government of India to have the railway constructed up to the very limits of Burma; but, beyond that, arrangements for the extension into Yunnan, if ultimately decided on, must rest entirely with the British Government on its own financial responsibility. This is more essentially the case if political and strategical reasons with regard to British interests and influence in China are to be allowed greater weight than purely commercial interests connected with the trade of Burma. If Imperial political considerations are to rule the British policy, then no doubt the City of London can very easily furnish millions of capital for railway construction at the low guarantee of 2½ to 3 per cent. with prospect of a share of further surplus earnings when (or if) realised.

The commercial prospects of enterprise in Yunnan, however, unfortunately appear anything but promising. British Chambers of Commerce, which have been told to look upon Yunnan as an Eldorado, must prepare themselves for the probability of disenchantment and disappointment. Such at any rate are the opinions held by the most reliable of those who are personally acquainted with the country through which the line of railway must pass in its proposed ascent into the mountainous tracts beyond the Salween. Consequently there are solid reasons for believing that British commercial interests in the immediate future would be better served by devoting the money which railway extension beyond the Salween would cost to linking together the Burma and Assam railways, to the construction of branch lines as feeders of the existing trunk lines, and to the formation of short new lines falling entirely within our own territories. There exist very favourable openings in Burma for profitable investment of capital, and it seems much more desirable t t money available in Britain should be w ll invested in our own fertile but only partly de- veloped province than that it should lie sunk in as yet questionable enterprises in the mount n tracts of Yunnan. I put these views forw d merely as my own individual opinions, which e based on a knowledge of Burma acquired y a service there extending over nearly a quarte of century, on personal acquaintance with almost every district in the province, and on recent to s in the Northern and the Southern Shan Sta s. But they coincide with other opinions in offi al and commercial circles, with the opini s reflected by the Press, with those rece y placed before the Rangoon Chamber of Co- merce by Mr. Hebbert (late Agent of the Bur a Railways Company) when on the point of leaving Burma in August last, and with th e of the Viceroy expressed in Durbar at Rang n on 8th December, 1898.* Any abnormally ex- pensive endeavour to tap the trade of Sou- Western Yunnan by means of a railway ll not be remunerative, for the very simple rea n that this lofty plateau produces nothing in the nature of a trade capable of great expans n. It is not asserted that it is in any way im- possible, as beyond our engineering skill to construct such a line to Talifu or further s to the banks of the Yangtse; but it is m n- tained that it will be enormously expensiv to build and to work, that it will not y adequate returns, and that in any case ex n- sions and ramifications of the railway e throughout Burma are preferable—unless c n

* What Lord Elgin said concerning the railway syst i Burma was as follows:—"It is already a great system a is capable of great development, and I say so after trav n over pretty nearly the whole of the 900 miles of whi consists and proceeding as far as it could for the present k me in the direction of what I conceive must be at leas ultimate objects of its ambition—namely, connecting k with Assam on the one side and China on the other. I s not be understood to mean that the realization of these h is near at hand. On the contrary, though I have no d in my own mind that the railways of Burma are des e some day to join hands with those of India and ta h adjacent provinces of the Chinese Empire—and perha should add, form a connection with the friendly kingd Siam—still, a good deal of this work lies outside the sp sphere of the Government of India, and, so far as we are cerned for the present, there are, in my judgment, more u calls upon us from within the province itself. I ventu say that the course which the Government of India taken is eminently calculated to ensure that our ene are turned in the right direction. I am more than ever sat that we did right when we handed over the manageme the Burma railways to a strong company, which can better than any Government department the necessiti commerce and command the support of European capita If, as I believe is the case, this port of Rangoon, which

ercial principles are to be subordinated to political and strategic considerations. To be ofitable, or even possible, trade must be ciprocal; and there seem to be no products Yunnan which can be utilised in exchange r goods of British manufacture to a sufficient tent to make the railway in question re- unerative.

The present population of Yunnan, number- g probably between 5,000,000 and 6,000,000 dependent mainly on agriculture, while one of e presumptive objects of the proposed rail- ay is to exploit the reputed mineral wealth of e province. But no coal has yet been found Yunnan, and even firewood for fuel is com- ratively scanty; and this will much increase e cost of working a railway. As for gold, why to Yunnan when the Wuntho gold-fields e within 12 to 20 miles of the Mu Valley ailway, and while the Paunglaung range hills, east of the Sittang river but within sy reach of the Rangoon-Mandalay line, is own to be rich in precious metals? Coal is ing worked at Kabwet, between the Irra- addy and the railway in the Katha district, d more important fields are believed to exist roughout the Northern Shan States within ach of the Mandalay-Kunlôn line. And, *fortiori*, if development of agriculture is other object in view, why not concentrate forts on the vast stretches of rich lands lying cleared and uncultivated throughout the ains and valleys of Burma itself? Again, l the agricultural produce Yunnan can yield hilies, onions, ginger, &c.) can be equally ll raised in Burma and in the Shan States, ile the cotton, betel-nuts, cutch, piece-goods, &c., required for Yunnan, necessary in fact, *must* be taken inland, either from the Irrawaddy at Bhamo, or else from emporia situated on our Burma railways. Hence, under any circumstances, we command the bulk of the trade that is possible, without embarking on questionable railway exten- sions of considerable financial magnitude in Yunnan.

The open railway lines in Burma convey a large and a steadily increasing traffic. The extension of the main line to Mogaung and Myitkyina will not be immediately remunera- tive, but it will become so in course of time. Between these two small towns the railway passes through dense malarious jungle, which will have to await the arrival of settlers before the forests can be cleared for permanent cultivation. The tapping of Yunnan by a rail- way would not bring down cultivators from Yunnan, for mountaineers soon sicken and die on the plains. Mogaung receives the pro- duce of the jade mines at Nanyaseik, above Kamaing, and the amber coming from Maing- khwan; while india-rubber from the wild forest tracts to the north, formerly taken by boat to Bhamo before it could be sent south, is now brought to Mogaung and Myitkyina for direct transport to Rangoon.

Since railway construction was commenced at Myitkyina a considerable portion of the Yunnan trade formerly borne on pack-mules and bullocks westwards through Momein to Bhamo has now been deflected fromthe Taiping Valley towards Myitkyina. It is quite likely that this deflection of the petty inland trade may continue, and that Myitkyina, a brand- new town, will, to a certain extent, grow at the expense of Bhamo. But, *cæteris paribus*, the valley route by the Taiping River is the easier track, and there seems no fear of the trade at Bhamo becoming extinguished. It is most pro- bable that trade may increase considerably, both at Myitkyina and Bhamo, though the limits of its possible expansion seem somewhat narrow. Bhamo, in addition to trade viâ the Taiping Valley, must contiuue to be the emporium of the Chinese muleteers coming down through Namkhan, our frontier town on the Shweli River, which was last year connected with Bhamo by means of a well-cleared track 56 miles in length.

In connection with the intimation that the preliminary surveys, arranged for by the enter- prise of syndicates in London, has wisely been assisted by Government with regard to the loan of officers, statements have recently been

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efited by the first fruits of railway enterprise, has doubled trade and population within the last 20 years, surely re is no reason why we should not look forward to a tinued growth of prosperity and wealth as the varied ducts of your country are given access to the markets of world. There is no failure in the demand for grain, ber, oil, coal, and other minerals, all of which you sess and all of which, I hope, you will be increasingly e to use and export owing to the gradual extension of r railways to the sources of supply as well as by the npletion of the main lines of road, which are already hing their way outwards from the centres of population o the undeveloped parts of the country."

The policy of the Government of India, above referred to, the annual Railway Conference of experts which meets l considers all railway projects suggested by the various al governments through India. The recommendations de to the Government of India by the conference are mitted after due deliberation and consideration of all the ious factors concerned, having regard both to the means command and to the probable results obtainable from ministrative, commercial, political, and strategic points of w. This seems to be at once the most practical and the st advantageous system that can possibly be devised the interests of the Indian Empire.

made in the Press that work on the Mandalay-Kunlôn line is proceeding rapidly, and that 200 miles are already all but complete. This is incorrect and misleading. From Myohaung junction to the foot of the Shan hills, a distance of about 13 miles, is all that was open, even for construction trains, last autumn. The ascent of the Shan hills, from a level of about 500 feet on the plain to 3,000 feet on the edge of the plateau within a distance of less than 10 miles, involves, with two reversing stations, a gradient of the unusual steepness of 1 in 25, which may ultimately, for public safety, have to be reduced at great expense to 1 in 40. The line should be opened as far as Maymyo (over 35 miles) next spring. The alignment follows a zig-zag course across the face of a precipitous hill, rounding sharp curves, passing under heavy cuttings and going through rocky galleries. When once this short section is opened and rails can reach the plateau, the laying of the permanent track can follow very rapidly up to about the 80th mile. Here the Gokteik Gorge offers a natural obstruction that will probably take the best part of two years to overcome. Earthwork and bridging are completed thus far, ballast has been collected, and only the rails are wanted to enable the permanent way to be laid.

The Gokteik Gorge is, however, a very formidable obstruction to further progress. A fissure in the hills, incomplete in one short portion resembling rather a geological fault, apparently resulted in once damming up the bed of the Gokteik stream, now lying hundreds of feet below. A lake must have been formed until in course of time the waters forced an outlet for themselves, by percolation and pressure, in the form of a subterraneous passage extending for about half a mile through the dam of limestone rock. The stream now disappears for this considerable distance into a huge cavern, while the fault above it forms a *ngôk*, or natural bridge, across which the old trade route from China to Mandalay passes.* Such *ngôk* are common throughout the Shan States, where the prevailing rock is limestor This gorge will be crossed by a lofty ir bridge between 400 and 500 feet above t stream, and 2,000 feet or more in length. T construction of this bridge will be costly a tedious. But when once this obstacle has be surmounted, there will be nothing of unusu difficulty to hinder the rails being rapidly la through Thibaw up to and beyond Lashio, t capital of the Northern Shan States, dista about 170 miles from Mandalay. An extensi bridge, crossing the Namsin stream abo eight miles before reaching Thibaw, will cau some delay: for, though the foundations a now being laid, further construction must delayed till the girders, &c., are brought up railway. The earthwork of the line is pract ally completed, and the station building platform, &c., are already constructed far as Lashio, though the rails are not like to be laid for about a couple of years.

Some who have had exceptionally go opportunities of forming a sound judgment the matter, are very strongly of opinion th one or other of the small towns of Mong Gy or Mong Kyek, respectively about 25 and miles east of Lashio—and preferably t former—should definitely form the terminus the railway line. Beyond that, the coun descending to the Salween again becom difficult, and the expense of construction a working will be considerable. The extens from Mong Kyek to the Salween River, will about 50 miles in length. But it seems n practically certain that construction up to Kunlôn will be pushed on as rapidly as possib

Beyond the Kunlôn ferry it will be about miles further to Talifu. Consul Jamieson, Szumao, in his report issued by the Forei office in December, 1898, quotes Babe remarks with approval:—"By piercing half dozen Mont Cenis tunnels, and erecting a Menai bridges, the road from Burma Yunnanfu could doubtless be much improved To begin with, Baber's remarks do not ap to the route now accepted as probably the m feasible; and, in the second place, this tone flippant exaggeration is not the proper man in which a question of such importance sho be approached from an official point of vi Great engineering difficulties undoubtedly exi but they must be examined in the true criti and practical spirit, neither deliberately und estimating nor unduly magnifying them.

It may be anticipated that the railway reach Kunlôn on the Salween in 1901 or 19 From the Kunlôn ferry, about 1,700 feet ab

* On the *ngôk*, just below where the bridge will cross, stands a quaint little monument, about 7 or 8 feet high. It is Chinese in form and appearance, and bears inscriptions in Chinese and Burmese. The latter runs as follows:—"On the second day of the waxing moon of Tabaung, 1233 (*i.e.*, about March, 1871), during the reign of the Thibaw Sawbwa, Mahawun-tha-thiha-dama Raja, this Yattaung pass, which was in bad condition, was repaired by the two Heins (headmen) of Yattein and Taungdeik, so as to make it passable for men and laden oxen. Hence they have earned the good wishes of the Nats (guardian spirits) and of men." It is to be hoped that this quaint record will not be destroyed when the bridge work begins.

a-level, a line can be formed on the farther de of the Salween, extending north-east up e Namting Valley and across a *col* about 500 feet in elevation to Yincho (Yunchu)*, id thence northwards for about 25 miles to iunningfu, both of which places are about e same elevation. This extension would be out 160 to 170 miles long. Over 30 miles of is would have to be of a gradient of 1 in 40. it it is only after reaching Yincho or Shunngfu that the really great obstruction becomes iavoidable. The Mekong, flowing from 20 to miles to the east of these towns, presents a rmidable obstacle as a gorge 2,000 feet deep, id between two and three miles in breadth. eyond that, the ascent to Talifu (7,000 feet) ill again entail a gradient of not less than 1 40 for at least 20 to 30 miles. Beyond Talifu e possible route and its obstacles are as yet ere conjecture. But I think sufficient has en said to show that railway construction into e heart of Yunnan will be abnormally high, id that the cost of working over high gradients ill be unusually heavy without natural supplies good steam-producing fuel near the eastern id of the line.

If for political purposes it be desired to extend e Mandalay-Kunlôn line into Yunnan, it iould not in the meantime proceed beyond incho or Shunningfu, either of which would rve as an additional focus and distributing ntre for any commerce capable of development. Later on, further knowledge would be quired which should make additional extensions, amounting to vast investments, less of a ap in the dark than must be the case if large orks are hurried on prematurely. It may rhaps be permissible to remark here that (or when) the Burma line is extended across unnan to the Kinsha-kiang or River of olden Sand, the main branch of the Yangtse, further extension is much more likely to northwards through Western Szechuan towards Thibet than eastwards through the wild olo country towards Suifu.

There seems to be an idea in England that e Shan States are rich, and that the tracts beyond them, *omne ignotum pro magnifico*, must be still richer—capable of developing an enormous amount of trade, in fact. This is hardly the case in the former instance, and it is not likely to be a correct estimate in the latter. When travelling along the roads leading up from the plains of Burma into the Northern and the Southern Shan States, one continually meets caravans of bullocks carrying small loads of about a hundredweight per head, packed in bamboo baskets slung over the withers of each animal, while the Chinese caravans consist both of bullocks and of mules carrying loads of about 120 lbs. But it must be recollected that, even with the limited number of trucks necessitated by the high gradients on parts of this line, one train could convey about 3,000 bullock loads; and when several hundreds of thousands of possible bullock or mule loads are converted into tons of traffic, the amount of commerce thereby represented is comparatively so unimportant that it fails to promise anything like adequate returns to a high-grade railway abnormally expensive to construct and to maintain and work.

Long caravan routes can never compete successfully with direct transport by river or rail when once this is provided. Hence, with regard to the railway line under construction towards the Kunlôn ferry, this will absorb all the caravan traffic now proceeding by way of Lashio and Thibaw to Mandalay. With the Kunlôn ferry as terminus in the meantime, caravan trade will be attracted towards the line both from our own Shan States and from the territories beyond. The bulk of whatever trade exists or is capable of development in the south-western portion of Yunnan must naturally, following the lines of least resistance, find its way into the Irrawaddy Valley, either through Sadôn to Myitkyina, or down the Taiping Valley (Manwaing) or the Shweli Valley (Namkhan) to Bhamo, or by the Kunlôn ferry to the railway line from Mandalay. The caravan traffic from the south of that which now crosses the Salween by the Takaw or other ferries and passes through Taunggyi, the head-quarters of the Southern Shan States, and thence proceeds down a fairly good road for 106 miles to the railway line at Thazi (or to the Pyawbwè station south of that, which offers better natural advantages as an emporium), may perhaps not be affected to any appreciable extent until the proposed branch line is, in course of time, made from Thibaw southwards through Kehsi Mansam to Mong Nai (Mone),

* Lieut. Roux, of the French Navy, who accompanied ince Henri d'Orleans (vide "From Tonquin to India," 1898, 372, 373), puts Meinningfu (Namting drainage) at 5,207 t, the pass between the Salween and the Mekong at 76 feet, Yunchow at 7,531 feet, Shunningfu at 5,584 feet, Mekong River at 3,604 feet, the pass on the north of the kong at 8,688, and Talifu at 7,007 feet. Unless Captain vies's new survey shows these observations of a highlyined naval officer to be vastly over-estimated, then the istruction of a line will require far longer stretches at 1 in than are here being suggested as probable.

the capital of the Shan State bearing the same name.

Much can, of course, be done to facilitate the attraction of trade to the existing railway and steamer lines. It seems to me that it would be of enormous advantage if British commercial syndicates could, in the first instance, in anticipation of subsequent railway concessions, secure the control and management of inland trade routes between the Yangtse and the Irrawaddy and Brahmaputra on guaranteeing to the Chinese Customs Department a sum in excess of the *likin* dues annually derived on the average during the last five years. This ought not to be impossible: nor should it be impossible to organise a semi-military transport system along improved trade routes in these western provinces marching with our Indian Empire. Apart from purely political and strategical considerations, the improvement of existing communications converging on important points on river or railway and the formation of branch lines of railway within Burma seem to afford much more promising commercial opportunities than the immediate construction of a railway into and across Yunnan. The Government of Burma can be confidently trusted to do its duty in this respect, so far as lies within its power; but it has for many years been the main grievance of this rich province that an undue share of its surplus revenue is usurped by the Government of India for Imperial purposes instead of being more liberally allotted for the improvement of communications in Burma. Last year the road from Bhamo to Namkhan, 56 miles, was made, and also another leading east from Bhamo for about 30 miles to Sinlumgaba, while this year one is to be constructed from Myitkyina to the frontier on the route to Momein. A good mule track has been opened out from Momeik, on the Shweli River, through Mogôk, the head-quarters of the Ruby Mines district, to Mainglôn in the Thibaw State, whence it can easily be extended south-west and south-east to meet the new railway line at Maymijo and at Pyaunggaung. With regard to fresh railway projects and the ramification of the existing railway lines throughout Burma, a field of commercial enterprise presents itself with far better prospect of immediately remunerative results than the scheme for traversing Yunnan. Thus, for example, Moulmeim can easily be connected with the Rangoon-Mandalay line; while the sea-port of Bassein is not yet served by any railway, although good opportunities are offered by the rich rice tracts extending northwards and east wards from it, back from the main river com munication. Again, numerous small branche could be very profitably thrown out from th Prome and the Mandalay lines to act as feede in facilitating the transport of rice and timber, the two main staple products of Burm to Rangoon.

In Upper Burma two important branch line are now in course of construction. One of thes about sixty miles in length, begun in 1896 as famine work, runs from Meiktila, the head quarters of the Meiktila division and an impo tant military station, to Myingyan on th Irrawaddy, near where this receives from th north-west its chief tributary, the Chindwi River. This line traverses the principal cotto producing district in Burma, whose shor stapled crop is largely exported into Yunna *viâ* Bhamo. From Sagaing another impo tant branch, about seventy miles long, is bein run through Myinmu and Mônywa to Alôn, o the Chindwin, which will pass through ferti rice lands and tracts producing cotton, cattl and salt. And in the near future a branc about 200 miles in length will most likely b extended southwards from Thibaw throug Kehsi-Mansam and Laikha to Mongn (Mone) in the heart of the Southern Sha States. Here a certain amount of trade alread exists, which is capable of being greatly in creased. The country is fairly fertile an possesses a good climate suitable for growin tea, coffee, fruits, vegetables, and grain, a well as for breeding cattle. Hence, given th railway, there would probably soon be a larg development of trade eastwards from Keng tung and the country beyond: for the Shan are endowed with very keen trading instinct Moreover, it will bring our military station Kengtung, now 350 miles distant from th railway line at Thazi, in considerably bett touch with its main bases at Mandalay an Rangoon.

The Shan States are not everywhere capab of being opened out to an unlimited extent. Thibaw, the most important of the Northe Shan States, which is being traversed fro west to east by the railway from Mandalay Lashio, irrigation is extensively adopted f cultivation. The soil, a very clayey loa resulting from the decomposition of limesto rock, is fertile so long as it has a sufficie supply of moisture. Already the original fore covering on the hillsides has in many plac been so much denuded that extensive furth clearings for cultivation may interfere prej

icially with the water-storage capacity of ıe soil, and consequently with its productivity nd with the well-being of the cultivators nd of their cattle. This is, however, a anger that will no doubt be guarded against ı due time by those responsible for the dministration of the State. The Forest epartment has already been put to work in ıe matter.

Remunerative extensions of the railway will lso ultimately be feasible beyond Mogaung; r the country in the north of the Myitkyina istrict, though poorly populated and as yet nly partially administered, is rich in future ossibilities. The project of linking up the urma line with the Assam Railway, for which ıe preliminary surveys were completed in 396, will probably again in due course be rought forward for more favourable con- deration.

And now to summarise briefly in conclusion. s has been above remarked, the despatch f Captain Davies's reconnaissance party into unnan is a spirited and enterprising com- ıercial movement. But unless it can be shown ıat railway construction extending far beyond ıe Salween will be less unduly expensive than as hitherto been surmised, and can offer ıe prospect of better returns than are nticipated by those most competent to rm an opinion on the subject, then the asons for advocating the immediate further evelopment of the railway net throughout urma, and for connecting it with Assam em much stronger than those for extend- ıg the line eastwards into China. No ressure has been brought to bear on Govern- ent by the Rangoon Chamber of Com- erce, the Press of Burma, or the Burma Rail- ays Company. If the project were really so omising as some would have us believe, these ould probably have been the first to urge the ecessity for action on the part of Government; r they have most to gain by whatever will crease the bulk of the trade passing through angoon. They, however, would prefer that e inland communications of Burma by road ıd rail should be improved, and that private ıpital should be encouraged to flow into urma for the rapid development of the ovince, rather than that the British or e Indian Government should commit them- lves in the immediate future to guarantees r extensive railway works extending across e mountainous tracts of Yunnan. By all eans let our position there be strengthened th politically and commercially; but this need not involve the construction of railways prematurely.

The paper was illustrated by a series of 28 views in Upper Burma and the Northern Shan States prepared from photographs kindly lent by Mr. Bagley, late engineer-in-chief, Burma Railways Company.

DISCUSSION.

The CHAIRMAN said this was a most interesting paper, and embodied the views which he, as Chief Commissioner of Burma, had formed and frequently expressed. With regard to the extension of the railway to Western Yunnan he never could convince himself that the trade that now existed was enough to justify the investment of British capital in railway extension, and he was perfectly clear that it would be monstrous to expend the revenues of India in extending the railway beyond British territory into China. He had had occasion from time to time to make inquiries into the existing trade between Burma and China, and it consisted largely of contraband—arms and opium—and instead of encouraging it every effort was made to stop it. The bulk of the rest of the trade coming from the parts of Yunnan they had heard of that evening consisted of orpiment and straw hats. He did not know how many caravans of straw hats it would take to make a load for one railway train, but he entirely endorsed the opinion that it would be very rash to form sanguine estimates of the prospects of a railway without careful inquiry as to the real value and bulk of the existing caravan trade. When he was Chief Commissioner in the Central Provinces in India, there was a plan proposed for the construction of a railway across the Satpura Hills, and he was told the traffic was very important, but on examination he came to the conclusion that one railway train a week would carry all the caravan trade of a month, which was not encouraging as a prospect for British investors. He entirely endorsed Dr. Nisbet's warning as to the difficulty of gauging caravan trade. He could not quite agree with Dr. Nisbet's opinion that it was as essential to have a through route from Shanghai and Honkong to the Brahmaputra and the Irrawaddy, as it was to have a through route from Alexandria to the Cape. He believed trade ought to be left to follow its natural lines, and the natural line of trade from that portion of China was eastward by the Yangtse River. You might make railways at an expenditure of millions, but they would not draw the trade from that river down to Burma, nor did he believe the trade and produce of the country was such as could bear the charges of railway conveyance from Yunnan to Rangoon. In any case, if that railway were made at all, it must be done at the cost of those enthusiasts who advocated it, and of those who believed in them, and not at the expense of the Government of India. With

regard to the railways in Burma, he endorsed every word of what had been said about the desirability of their extension, having had a good deal to do with suggesting and carrying out some of the lines mentioned in the paper read. With regard to the line to Myitkyina, he did not suppose the amount of Chinese trade which would be attracted there, or the produce of the country itself would for many years provide a paying traffic for the railway, but they were compelled to make it, and it paid indirectly. As had been explained and shown in the views, the defiles were practically an immense difficulty to keeping up communication by the river; but there were frequent outbreaks amongst the tribes in that neighbourhood, and expeditions had constantly to be sent there, and all the year's supplies for the military police had to be sent by river through these defiles while they were open, within a very limited period of time. This was a costly process, and entailed the maintenance of a large flotilla of river steamers, which were constantly getting wrecked in the defile. The making of the railway would enable this flotilla to be dispensed with, and he believed there were great capabilities in that part of the country. At one time certainly it was populous, and if they ever got that direct communication between Assam and Burma which was advocated—wisely he believed—it would be through the Hukong Valley. He had no doubt that the Lower Burma lines would pay, and that there was a practically unlimited field for extension there. Turning once more to the Mandalay and Kunlôn line, the view he had always taken of it was this: He advocated the construction of the line as far as Thibaw, and up to there he believed it would pay, but he deprecated its continuation to Kunlôn because he did not believe it would get any traffic worth considering, at any rate not until British capital was able to penetrate into Yunnan, and develop the mineral wealth, if such existed. He advocated strongly the extension southwards from Thibaw through the Shan States, of which he thought Dr. Nisbet had taken rather an unfavourable view. These were small principalities which prior to the annexation had been torn by internecine war, and when we took possession of them they were depopulated by constant warfare, but had since been recovering in the most marvellous way. Population was returning, trade was developing, and on the hills there the climate was as good as that of England at its best —far better than we were enjoying at present. The Superintendent of the Southern Shan States told him that he could wear all the year round the same clothes he wore in London; that he grew every description of English fruit and vegetables, and was prepared to grow potatoes for the whole British army if he had sufficient encouragement. He added that he kept his box of matches open on the table, and they never failed to strike, and anyone who knew the difficulty there was in getting a match to strike at all in Burma would understand what that meant. Sanitaria for the troops in Burma were sadly wanted, and up in the Shan hills there were magnificent and healthy site —almost, in fact, suited for European colonisation. I had been suggested that France would be disposed t make decent arrangements in Madagascar and else where if she could get Siam, but he hoped this woul never be allowed, for if she did we should certainl have trouble in Burma; and he looked upon th extension of the railway down through the Sha States as one of the most important strategic move ments which could be made, because it would protec the flank of Burma against any advance from Siam c Annam. He agreed with Dr. Nisbet that there wa a good deal to be done for the development of th industries as well as the railways of Burma; and he di not think the Government of India had done all tha it might, and that our regulations had been far to grandmotherly. They were always trying to protec the British investor; but his experience was that th investor was able to protect himself. All that wa necessary was to take care that the truth wa laid before him, and to punish anyone wh did not state the truth in prospectuses, an so on; and he thought our Judges, both i England and India, might be trusted to do that but the rules for developing the gold mining, coa mining, and other such industries ought to be ver materially relaxed, and a fair chance ought to b given to British capital to develop the country. H was not surprised to hear it said in Rangoon that i would be a good thing for Burma if it were cut loos from India altogether, and there was undoubtedly strong feeling amongst the European commerci population there that Burma did not always get fa treatment. He was perfectly satisfied that if Burm stood by herself, under the Colonial Office, it woul pay its way, taking the two provinces together; bu being attached to India it was saddled with muc expenditure which more properly belonged to tha country. However, if more prosperous days wer coming in India, no doubt Burma would share i them. The first requirement was the free investmen of British capital, both in India and Burma, whic would never come about until they had got a stab par of exchange; and that he hoped the committe now sitting at the India Office would see its way e long to provide for—though how it was to be don he would not attempt to say. Dr. Nisbet said tha tracts of country on the Myitkyina line would be un cultivated for some time, because the mountainee who came to cultivate them could not live in th plains; but on the Bhamo side there had been trib coming over the Chinese border who in past yea cultivated nearly the whole of the Bhamo Valley, an were ready to do so now if only the Chinese woul let them emigrate. If we could only establish fre trade in the fullest sense, across the border, we shoul soon see the whole of that valley recultivated, and large revenue arising therefrom.

Mr. ARCHIBALD LITTLE said he was afraid, aft hearing such a detailed account of the border countr

etween Burma and Yunnan, they would say that he immediate connection of Chungking—the part of :hina in which he was personally interested—with Burma was not likely to be accomplished in the near uture. Even the line to the Kunlôn ferry on the ;alween river would not be completed for several ears, and the possibility of extending it on to 'unnan seemed rather remote. He feared that until 'unnan was properly governed and re-populated— or it had been devastated by the cruel massacres which accompanied the outbreak of the Mohammedan ebellion and its suppression by the Chinese, and he officials appointed by the Government to revive he province and restore confidence were totally ncapable,—there was very little hope. Even if the 'rench took possession of it, it would be better than eaving it as it was. Seeing the natural difficulties f the country, Hong Kong was practically nearer o Yunnan than Rangoon. The natural route to he Yunnan plateau was by the eastern ascent, because it was very gradual and was not interrupted by he high mountains and—in a railway sense—terrible ountry which separated Burma from China. There vas already an open part at Woochow on the West River of Canton, and the river was navigable from ts mouth, 510 miles to Posai, where there was aid to be about 3 feet of water; there was then very possibility of light draught steamers being able o get there. From Posai the ascent was gradual, nd though the country had not been surveyed ravellers said there was no difficulty in pushing a ailway from there to the high Yunnan plateau, at east as far as Yunnanfu. It appeared to him, there-ore, that practical men who wished to invest their noney, would do better to open the route from the ast, in which no serious difficulties occurred, than o push for a scheme which was quite impracticable n the near future. Dr. Nisbet referred with leasure to the telegram from Sir Lister Kaye, who had obtained a concession from the Chinese Government for the conservancy of the Yangtse iver, and was to reimburse himself by means of toll, but he must say that he hoped no private ompany would be allowed to impose tolls on hat river. If any expenditure were required, it hould be carried out by our own Admiralty, for, in country like China, it would be bad policy to tax he junk traffic with a toll, especially as the cost would e comparatively trifling. For six months of the ears the rocks were so far below—for the Yangtse ose 100 feet—that there was no need to interfere ith them at all; and if a few rocks were removed om some of the rapids, the navigation would be afe all the year round. He agreed with Dr. Nisbet hat it would be well if some of the many Chinese yndicates would join their forces and co-operate. Our Government should try and arrange for something like an international commission or permanent ailway and mining board in China, to whom all roposed schemes should be submitted. Nothing was more needed at present than liberty to mine; there was no liberty for Europeans nor even for the Chinese themselves. One had to go in a roundabout way and get the consent of the local authorities, and then to go to Pekin and spend large sums in bribery, and even if one got a concession it was on such onerous terms that he doubted if many of the railways now being promoted would ever be built. One concession he saw stipulated that the whole line, including the rolling stock, should be handed over to the Chinese Government at the end of 30 years! He could not believe that such concessions were intended to be honestly carried out. With regard to mines, the Chinese Government ought to give leave to any *bonâ fide* resident in the country, in partnership with the natives, to open a mine and so enrich the people and enable them to buy more of our goods; for at present the masses were in abject poverty. The country would never be developed until anybody who had capital and agreed with the local proprietors was allowed to work a mine.

Mr. HORACE BELL being called upon, said the only points he could have raised had already been covered by the Chairman. However easy or difficult it might be to get across from Burma into Yunnan with a railway, he feared the traffic obtainable would not be sufficient to pay interest on the cost; and he agreed with Mr. Little, that the traffic was much more likely to be with Hong Kong than with Rangoon.

Sir STEUART BAYLEY, K.C.S.I., C.I.E., congratulated the Society and the Indian Section on the high character of the paper with which the session had been inaugurated, and tendered the cordial thanks of the meeting, both to thea uthor and to the Chairman, for his kindness in presiding.

Mr. C. McL. McHARDY said if it was not too late, he should like to ask for a little further information from the Chairman on one point. They had been told that much advantage was not to be expected from an extension of the railway from Burma into Yunnan, but that it would be of great advantage to continue it northward into Upper Burma, and to make certain branch lines, also to make a line from the east into Yunnan. He should like to know something more of the population and products of Upper Burma, and as to whether there was a large population in Yunnan to buy goods sent from the east, and what produce there was to export from Yunnan. He rather gathered, from what had been said to-day, that beyond some straw hats very little was to be had from Yunnan, and that there was but a small population, most of whom had been killed in the Mohammedan rebellion, in which case we could not expect them to buy much or produce much. If such be the position of affairs, what was the use of constructing a railway? His own impression was that Yunnan was one of the very poorest and most thinly-inhabited part of the Chinese empire, and that there were other parts in which British capital could be more profitably invested.

The CHAIRMAN said Lower Burma was one of the richest rice-producing countries in the world. Upper Burma had in the centre a dry zone, consisting of half-a-dozen districts, which frequently suffered from a low rainfall, but when they did get rain were very fertile. When the rain did not come they had what were called famines, but a famine in Burma was a very mild affair compared to a famine in Madras. These dry districts, he had very little doubt, could be made perfectly free from drought by a system of irrigation works, not of the expensive nature usual in India, but by the cheap and easy methods formerly adopted by the Burmese kings. North of this dry zone there were districts with as fertile a soil as could be wished, growing wheat and rice. The population was sparse compared with Lower Burma and parts of India, and in some places there were large tracts of forest, where a good deal of money was made by cutting timber. The mining capacities of the country were as yet hardly explored; coal mining had not been very successful, and the gold was barely touched, and he should be glad to see the conditions made easier for those who liked to take the risk. When you got to Mogaung in the north, you were close to the jade mines, and for this mineral very large prices were paid by the Chinese, and that would be one of the principal things sent down by the railway. Farther north again there was another tract at present very sparsely populated, where you got rubber and amber, especially the former. That tract had hitherto been in the hands of tribes who had done a good deal of damage to the trees, but he thought the capacities of the country were fairly good. He did not advise people to rush and invest money in enterprises in Upper Burma; but there was certainly a field for exploration and development, and financially the fact remained that up to the present we had supplied the country with the whole paraphernalia of decent administration, and yet had almost succeeded in making it pay. When he first went to Burma he had 18,000 men in the military police, a great number of them Pathans, the finest fighting material in India, though when they were in cantonments with nothing to do they were apt to get unruly and dangerous. Many of them had now been drafted into the regular regiments of the Madras Army, thereby reducing the cost of occupation; the country was rapidly settling down, and taking Lower Burma and Upper Burma together the Government might congratulate itself that it practically paid its way. With regard to China, he would rather that Mr. Little should answer the question. His own impression was that Yunnan was a very poor country; but he thought that the English Government had succeeded in getting valuable concessions for British syndicates in China, more valuable than the public had any idea of, but as to whether those concessions would prove workable or not he expressed no opinion. It was said that in the north Russia was of opinion that she could not work her railways without making military stations in connection with them. If it were necessary for the employment of British capital i[n] Central China to support it by a military force, h[e] doubted greatly whether the British Governmen[t] would undertake that responsibility.

Mr. LITTLE said the eastern part of Yunnan was [a] fairly good country, producing—apart from its copp[er] and tin mines—the best opium in China, which co[st] in carriage very often 10d. to 1s. per ton mile, [as] against ½d. or 1d. per railway. The route from th[e] West River would be for 500 miles by water, and [it] was not more than 300 miles from Posai to Yunnanf[u]. It would also tap Kwaichow, with rich valleys, pro[-] ducing rice and other subtropical crops. He did n[ot] deprecate a railway from Burma to Chungking, if [it] could be made to pay; but it would be an expensi[ve] line, whereas the route from the West River by wat[er] would be inexpensive, and he was confident the[re] would be a good traffic in Manchester goods goin[g] inland, and opium and minor products coming bac[k]. As a Britisher, he should much like to see th[e] railway made, because it would relieve us from th[e] iniquitous transit of 10 per cent., which the Frenc[h] imposed for passing through a little corner of the[ir] territory, whilst French goods went through fre[e]. It was little matters like that which made the[m] jealous of any French expansion; otherwise, th[e] country would be better under French rule than und[er] Chinese. The easiest way to oppose them peacefull[y] was to make a line through from Hong Kong t[o] Yunnan fu.

SEVENTH ORDINARY MEETING.

Wednesday, Jan. 25, 1899; R. BRUDENEL[L] CARTER, F.R.C.S., Vice-President of th[e] Society, in the chair.

The following candidates were proposed fo[r] election as members of the Society:—

Bunyard, George, Kenmore, Maidstone.
Capel, G. W., Montana, Park-lane, Croydon.
Collis, John William, 55, Glenwood-road, Catford, S.E.
Colman, Russell J., Carrow Works, Norwich.
Evans, Peter MacIntyre, M.A., Clothworkers' Hal[l], Mincing-lane, E.C.
Flint, Stanley, 12, Museum-chambers, Bury-street, W.C.
Gray, Frank James, 9, Upper King-street, Norwich.
Hunter, Walter, 17, Victoria-street, S.W.
Ramsay, James, Listoke, St. Stephen's-road, Ealing, W.
Ranger, Charles Peter, Easthoathly, Sussex.
Wilson, John, Leadenhall-house, 101, Leadenhall-street, E.C.

The following candidates were balloted fo[r] and duly elected members of the Society:—

Digby, William P., Valyevo, Wanstead-road, Bromley, Kent.

cking, Charles Leonard, The Gables, Nightingale-ane, Clapham-common, S.W.
rries, David, Portland College, High-road, hiswick, W.
ng, John Alexander, Rosendale, Stanstead-road, Forest-hill, S.E.
riarty, Hon. Arthur S., I.C.S., care of Messrs. rindlay, Groom and Co., Bombay.
illips, H. Fentum, Guildford Electrical Works, North-street, Guildford.

The paper read was—

TUBERCULOSIS IN ANIMALS.

By W. Hunting.

Once every month the daily papers publish tracts from the returns of the Registrar-neral showing the causes of mortality among population of these islands. When typhoid, all-pox, or scarlet fever destroy an extra ndred of human lives, popular attention comes arrested, and, should the mortality ntinue, public agitation soon arises. A zen deaths from hydrophobia in one year is signal for issuing most stringent regula-ns—enforced by fine or imprisonment. One se of suspected cholera in any of our ports sufficient to cause something approaching nic. A report that a ship has reached our ast, and that a death has occurred on it m plague, is an event noticed by every wspaper in the country.

All this is well known, and the general blic approve of the stringent measures taken our authorities—central and local—to pre-nt further loss of human life. The diseases ntioned are dangerous plagues, and it is in cordance with reason and common sense at every precaution should be taken to pre-nt their spread. The public appreciate the nger, and the Legislature has provided asures of protection.

There is a disease that destroys more human ings than all the plagues I have named put gether. There is a disease the returns of rtality never mention — a disease about ich the Press and the public are apparently norant, and which the Legislature ignores.

We constantly hear of typhoid, small-pox, d cholera, but we seldom hear of tuberculosis tside of medical books. The absolute want knowledge of the disease is what protects it m any public movement, and from all legis-ive interference. At Marlborough House st December Sir William Broadbent stated at 70,000 persons die every year in Great itain and Ireland from tubercular disease. hy is the death of 100 persons from typhoid, or of a dozen from hydrophobia a cause of popular indignation, whilst the death of thousands every month from tuberculosis goes on unnoticed and unchecked? The explanation is that the public recognise the preventability of those diseases but not of this. The loss from one is slow, obscure, and constant. The loss from the others is sudden, evident, and occasional. We all know the dangers of small-pox, typhoid, and hydrophobia; we take what precautions we can, and look to legislation for assistance in limiting their spread. The greatest of all plagues is lost sight of—its very name is unused, and it is disguised in the published returns of mortality by inclusion in "disease of the respiratory organs," or "disease of the digestive organs." To class a specific disease like tuberculosis in this way is as logical as to include small-pox in the list of "diseases of the skin." Such returns defeat the object of publicity—they disguise a grave public danger instead of exposing it. Seventy thousand deaths per aunum from one disease—one preventable disease—is a terrible event; more terrible from the fact that no public alarm is raised and no legislative attempt made to stay its progress.

But what has this to do with the subject of my paper? What has human mortality to do with bovine tuberculosis? A very great deal. Tuberculosis in cattle is one of the causes which leads to the annual hecatomb of human beings, a cause which might be most easily removed. Sir Richard Thorne, in a lecture delivered last November, drew attention to the fact that during the last half-century a great reduction in the death-rate from many forms of tuberculosis in man had taken place. This he attributed to the improved sanitary arrangements now adopted—to improved ventilation, to better hygienic surroundings, and to less over-crowding in houses and workshops. When, however, the statistics were examined of those forms of tuberculosis which were not from infection through the lungs but through the stomach, it was found that no decrease was apparent. On the contrary, the mortality of children under one year old from abdominal tuberculosis had increased, and this increase had gone hand-in-hand with the steady increase in the consumption of cows' milk. No other explanation can be found for this constant annual slaughter of the innocents except infected milk, and the medical profession accept the cause pointed out by the chief medical officer of the Government.

What is tuberculosis? It is a disease

affecting man and animals. It is due to the existence of a living organism—a microbe—in the system of the victim. It spreads solely by the transmission of the microbe from diseased to healthy bodies. The usual method of human infection is by a person suffering from consumption, *i.e.*, from tuberculosis affecting the lungs. Another method is the ingestion of infected flesh and milk derived from tuberculous cattle. A Royal Commission sat for four years enquiring into this question, and reported in 1895 that the danger of infection from tuberculous milk is a serious one, while the danger from tuberculous meat, though slighter, must not be disregarded.

Here then is authoritative evidence showing the connection between tuberculosis in man and in animals. The degree of danger depends upon the extent to which disease prevails among cattle, and there is reason to believe that at least 20 per cent. of the cattle over two years old are more or less affected with tuberculosis. In some districts the disease is almost unknown, in others it is common. Cows kept for milking purposes show the greatest amount of infection, and some sheds have been found in which 60 per cent. of the stock was infected.

The two channels through which tuberculosis may be transmitted from cattle to human beings are: meat and milk. Each is worth a little separate consideration.

Meat.

Under various Public Health Acts some attempt has been made to protect the public from the danger of consuming tuberculous meat. Sanitary inspectors, acting under the direction of medical officers of health, may seize diseased meat in shops or slaughter-houses, or wherever it is exposed or prepared for sale. Where animals are killed in public abattoirs inspection is easy, and when the inspector understands his duties—which is seldom—no dangerously diseased meat is likely to escape seizure. In this country by far the larger proportion of meat is prepared in private slaughter-houses, where inspection practically does not exist, and where its proper performance would entail the appointment of a small army of inspectors. All infected carcases are not equally dangerous. Tuberculosis may be indicated in one animal by a few nodules in one organ, in another by a general disease implicating the whole body. The latter state requires seizure of the whole carcase; the former may be treated as a local infection and the carcase passed after remo of the diseased organs. Between these t extremes of infection every imaginable deg of disease-distribution is to be met with, a the decision as to whether a carcase should seized in whole or part becomes a question an expert. When inspection has been lax, the inspector incapable, much dangerous m has been passed for human consumption. the other hand, when inspection has be based upon the theory that any visible inf tion of a carcase contaminates the ent body, great hardship has been inflicted up butchers by confiscation of the whole anima

There are few cattle in which the detecti of tuberculosis is difficult after death. Th are many in which during life no sign disease is discoverable, but which prove examination after slaughter so extensiv diseased as to render the carcase unfit human consumption. Hence arises a seri hardship to the butcher, who after hones purchasing an apparently healthy animal, h the carcase seized by the authorities. It argued that this loss to the butcher must looked upon as an ordinary trade risk, and t whilst he is deserving of sympathy he m not be allowed to sell meat which is a gra danger to human life. Not unnaturally t butcher replies: "I am not to blame. bought an apparently perfectly healthy anim and only discovered the dangerous conditi after slaughter. The public health shou certainly be protected—but at the public co My property may be justly seized, but in equ justice I should be compensated for it." shall refer to this question again, but here would point out that the effect of seizure wit out compensation is to drive away fro slaughter-houses where inspection takes pla all the suspected or diseased animals whi the owner thinks—be he butcher or not—mig fail to pass inspection. The worst tuberc lous carcases do not go to public abattoi but they find their way through priva slaughter-houses to the kitchens of the me consumers. Fortunately, thorough cooki renders tuberculous meat harmless, but n everyone is satisfied with an over-cook joint.

The controversial question of having on public slaughter-houses I have no time n to discuss. It is a very large one and includ much more than the detection of tuberculo meat. Public abattoirs in towns are of litt use if private slaughter-houses are permitt to remain, or even if meat killed outside t

...n is allowed to enter by road or rail without ...ection. To protect the public completely ...n tuberculous meat by inspection, would ...uire the total prohibition of private ...ghter-houses and prohibition of movement ...arcases until officially stamped. For other ...sons this may be found advisable and ...ctical, but as a protection against tubercu...s, it would be more cumbersome and costly ...n the stamping-out of the disease.

Milk.

...he transmission of tuberculosis from animals ...nan by means of infected milk is a much ...re serious danger than the possibility of ...ction by meat. Large quantities of milk ... consumed uncooked, and constitute a grave ...ger. Especially is the danger from this ...se imminent for infants and young children, ...or invalids weakened and debilitated from ...cent attack of typhoid or scarlet-fever.

...Not every tuberculous cow produces impure ...k. It seems in fact that only those animals ...o have tubercular disease of the udder, ...d infective milk. If the specific condition ...the udder were always prominent and easily ...ected, the danger might be guarded against ...removal of the cow, but it is not so. The ...ease commences insidiously, progresses ...idly, and infects the milk in the gland in ...very early stages. Milk from a tuberculous ...der is virulently infective, and one case is ...orded where half a wine-glassfull mixed with ... food of two rabbits caused their death from ...neral tuberculosis in a few weeks.

...n a remarkably able paper by Dr. Niven, ... Medical Officer of Health for Manchester, ...d before the meeting of the Sanitary Insti...e at Birmingham last year, some definite ...ormation concerning the infection of milk ...given. From this paper I take the follow...:—

...n Liverpool, 144 samples of milk from city ...w-sheds were examined, and 29 per cent. ...re found to contain tubercular infective ...tter. Of 24 samples of milk taken at the ...lway stations, 2 per cent. were infected.

...In Manchester, the milk from 19 tubercular ...ws was examined; that from five contained ...berculous infection, and all five cows had ...berculous udders.

...In Manchester, 93 samples were taken at ...e railway stations, and 18 per cent. were ...und by Professor Delapine to contain tuber...lar infective matter. By permission of the ...rmers from whom these infected milks were ...ceived, Mr. King, the City Veterinary Officer, examined the cows on 16 farms. On 14 of them, at least one cow was found with disease of the udder.

"It thus appears," says Dr. Niven, "that at the present time an enormous stream of infectious milk is pouring into our cities, and that the matter is truly one of urgency."

That this grave condition is urgent and serious will be better understood when I say that at present there are no powers afforded by law for the seizure of cows in the last stages of tuberculosis, although their udders are loaded with disease, and their milk is mixed daily with the produce of large cowsheds.

Probably enough has been said to show that tuberculosis in animals is a danger to public health, and at the same time a cause of great loss to butchers and cowkeepers. Neither butchers nor cowkeepers have any interest in owning diseased animals. They sustain nothing but loss through them, and are unable to avoid purchasing them. The disease prevails widely in the stock owned by breeders and feeders, from whom the cow-keeper and butcher must obtain the necessary animals to carry on their business. It is essential that human life should be protected against the transmission of disease by meat and milk, but the most stringent inspection of cow-sheds and slaughter-houses will not affect the prevalence of disease outside those places. By thorough inspection and ruthless seizure of diseased products in the possession of butchers and cow-keepers, partial protection may be given to public health, but so long as disease in the stocks of breeders and feeders of cattle is left untouched, so long will fresh supplies of infected animals enter the places from which the direct supply of food for man is obtained.

The usages of trade do not provide for warranties of soundness on the sale of cattle. The diagnosis of disease is impossible in fairs and markets. The butcher who buys an animal for the production of meat, and the cowkeeper who buys stock for the production of milk have no ready means of self-protection against the seller of tuberculous cattle. If the public is to be protected against disease, it is unfair to place the whole cost of such protection on the shoulders of the butcher and cowkeeper, whilst the breeder and feeder, who have full opportunity for recognising the state of their stock, are allowed to keep diseased cattle and sell them without restriction and without loss.

The agriculturist is, however, himself a sufferer, and deserves all the assistance that

can be given him. Tuberculosis causes continuous loss to him through abortion and sterility, through wasting disease and death, through the interference with fattening and the excess of food required to feed diseased animals. Although probably 20 per cent. of the adult cattle of the country are more or less infected, only about 1 per cent. show visible signs of the disease, and prove a total loss in any year. If we take the cattle stock of the kingdom at 6,500,000, and put aside those under two years old as being very slightly affected, we have 4,000,000 animals concerning which the estimate may be made that 1 per cent. are distinctly diseased—unfit either for meat or milk production. This would put the annual loss from bovine tuberculosis at 40,000 animals, and is sufficient to warrant legislative assistance and control.

Firm control of the disease would be an advantage to all classes. Public health and national wealth would both benefit by the suppression of a plague that injures all and does good to none. Regulations for its control are loudly called for by every interest, but most loudly by the requirements of public polity. Everyone who has given the subject a little thought is satisfied that something ought to be done. Some would trust in voluntary effort, others insist on the necessity of legislative action. Let us examine both methods.

Voluntary Effort.

Without some voluntary effort on the part of stockowners legislation can achieve little. Voluntary effort alone has never yet stayed the spread of contagious disease among animals. Carelessness, ignorance and greed are not peculiar to any classes of the community, and until human nature is exempt from these vices only the best of men will endure trouble and loss for the protection of others' interests. The easiest and most profitable method of getting rid of contagious disease in animals is to pass it on to your neighbour by selling the stock in the open market, and thus increasing the spread of infection. There is no law to prevent it, and the approval of thick-and-thin advisers of voluntary effort will doubtless be given. The public by voluntary effort may protect themselves against the dangers of tubercular infection from meat and milk. This can be done by well boiling all milk before consuming it, and by thoroughly cooking all meat before eating it. This is so simple that logically the public have not very strong grounds for insisting that meat should be f
from the tubercle bacillus. It is harml
when cooked, and so everyone can prot
himself. And yet no one has objected to
provisions of the Public Health Acts wh
provide for the seizure of tuberculous meat

Again with milk, safety can be obtained
boiling, and yet Sir William Broadbent clain
in his speech at Marlborough House that "
public had a right to insist that their m
should be absolutely free from the tuber
bacillus."

The supporters of purely voluntary act
should apply to the consumers of meat a
milk the same arguments they enforce wh
the owners of diseased cattle are referred to.
we are to do nothing by law save when self-p
tection is impossible, let us do nothing all rou
I expect this argument will gain few su
porters. It will be said that we want meat a
milk without the addition of a virulent poiso
that over-cooked meat and boiled milk a
not palatable, and some will agree with
that the digestion of meat and milk is
assisted by excessive cooking.

The butcher, the cow-keeper and the ag
culturist may do a great deal by volunta
effort to guard themselves against disea
in their animals and at the same time
protect the public.

Before I discuss what they may do, it w
be necessary to say something about the mea
we have at our disposal for the detection
disease.

A few years ago it was quite impossible
detect the majority of cases of tuberculosis
any animal. The majority of cases are alwa
those which have not yet caused any mark
disturbance and which present no indicati
of their existence to the ordinary observ
Tuberculosis is usually of slow develo
ment. After infection, months may pa
during which no indication of the disease
given, but a post-mortem examination wou
reveal distinct lesions in perhaps many par
of the body. Every infected animal has
chance of spontaneous recovery, and a st
greater chance of existence for a time witho
apparent injury. During the stage of late
disease, whilst lesions are developing in th
body and centres of infection gradually in
creasing, many exciting causes come into pla
give rise to systemic disturbance and distin
appearances of disease. Probably during th
latent period of tuberculosis not much dang
of infection to other animals exists, but in tho
cases where the lungs or bowels are implicate

s impossible to say at what time infective us may be expelled by coughing or may ape with the excreta. The detection of the vanced cases, which afford visible symptoms disease, is not difficult, and they may be noved from the possibility of infecting other mals. It is clear, however, that the spread he disease can only be controlled by detect- the latent cases before they reach the stage which they constantly transmit infection aving detected them, they must be submitted such isolation as will prevent their con- ninating healthy stock when they reach that age of disease which is surely contagious.

A few years ago this was quite impossible, t now, thanks to Dr. Koch's discovery of berculin, every infected animal can be rapidly tected and provision made for suppressing y transmission of disease. The tuberculin st for tuberculosis in cattle has, by innumer- le experiments, been established on a firm undation as harmless, yet trustworthy. In few hours it is possible to determine, on a rm or in a shed, which animals are infected d which are not. Then they may be separ- ed and the diseased kept strictly by them- lves.

By voluntary effort the agriculturist is able detect the existence of tuberculosis in his ock, to separate the healthy from the infected, keep only healthy animals, and to dispose all the diseased. Professor Bang, of Copen- agen, has demonstrated the practical success this method on a large scale, and has even own how a breeding stud of infected animals ay be continued for years without implicating e offspring, if care be taken to avoid con- gion. Sir Gibson Carmichael, in Scotland, opted this voluntary method on his pedigree ud at Castlecraig and has now a herd free om tuberculosis. The late Lord Vernon, at dbury, quite recently put into practice the berculin test, followed by weeding out the fected, with great success. The Duke of estminster and the Earl of Crewe have also ven practical approval to this method. A umber of other private owners have partially lopted it and a few have gone so far as to tect all their infected stock by means of tuber- ilin, and then have disposed of them so that ss knowing men may enjoy the loss they have aded. Supporters of the "voluntary system" o often describe the tuberculin test and its oper sequelæ as simple, easy, and efficacious. is indeed efficacious, but it is far from simple id easy. The use of tuberculin requires, first all, a trained veterinary surgeon for its application. This means expense. Next, the separation of infected stock must be carried out, and this means space for the purpose and extra buildings for isolation. To sell all the infected animals is a "dirty trick," if it is not reckless waste, as many would not be in condition for the butcher. Valuable breeding cows could be kept for their special services, but only under conditions which are available to rich men, or on places where sheds and pastures are unlimited. The voluntary suppression of tuberculosis on a farm by the tuberculin test and rigid separation is at present only practical for rich men and philanthropists. It is quite possible if capital and space are obtainable. It is even profitable under those conditions and where the stock is one of valuable pedigree animals.

In town cow-sheds, the provisions for isolation do not exist, besides which it is next to impossible to prevent the re-introduction of disease by newly purchased cows. Furthermore there is no inducement to keep only non-infected cows. The customers will not pay an extra price for pure milk, and even public institutions such as schools, hospitals, &c., offer no encouragement to a cowkeeper, either by extra payment or by compulsory regulations, to guarantee purity. There is, too, less commercial inducement for the cowkeeper than for the breeder, to employ tuberculin and thorough voluntary effort. The breeder keeps his stock for years and need seldom introduce animals from without. The cowkeeper retains his only so long as they yield a full supply of milk, and then he replaces them by new purchases from farmers and breeders. Tuberculosis runs a slow course, and, therefore, may occasion little loss by spreading among animals when a year is the average time of their existence.

When the public awaken to the danger of tuberculous milk, the Legislature will be obliged to insist upon the absence of tuberculous cows from milk-sheds. Then the cowkeeper will be forced to adopt measures of self-protection. He will have to clear his herd, and he will have to guard against the constant risk of purchasing infected cows. He may do this by a trade combination insisting upon all purchases being warranted free from tuberculosis. The individual who attempted to enforce such a warranty at the present time, would fail to obtain the stock he required to carry on his business, or he would have to pay from three to four pounds per head more for them. A strong trade combination might enforce a

warranty, but the effect of such action would at first be to give the careless and dishonest man the pick of the best milkers on the market. This would right itself in time because the negligent buyer would soon have evidence of disease in his shed, and suffer accordingly. The cowkeeper who bought on a warranty could only ensure the value of it by testing his new purchases with tuberculin. The warranty would have a time limit, so that the vendor might not be unfairly treated. But even with this care, and supposing a trade combination could be effected, the voluntary effort would not be safe. Any one can obtain and use tuberculin; after a few injections the reaction ceases or becomes very dubiously indicative. Dishonest dealers might by repeated injections render cows immune against reaction, and then a cowkeeper would have no means of defence against tuberculosis even if he had a warranty. Voluntary effort is insufficient, and unless the law steps in to assist honest traders the public must continue to face the risk of tuberculous milk.

The butcher is at present in the worst position, because the law provides penalties for the sale of diseased meat. The law puts no restraint on tuberculous disease affecting animals in farms or in cow-sheds, but it seizes the infected carcase when it comes into the possession of the butcher. The butcher buys what he believes to be a healthy beast; he is unable to detect disease during life, which may be laid bare by post-mortem examination, but he has to suffer for whatever the meat inspector detects. How is the butcher to apply voluntary effort? There are only two methods open to him. He may form trade combinations to purchase only on a warranty of freedom from disease—not, of course, an absolute freedom, but such a practically sound condition as will enable an inspector to pass the carcase in whole or part. This is being tried in some districts, but is very difficult to enforce, as the salesmen throw in their lot with the farmers to oppose the butchers.

Another plan which is being tried, but which has not made much advance, is for the butchers of a district to form a mutual insurance fund, as is done by shipowners. So much a head on all purchases is paid to the fund, and all loss sustained by seizure at the slaughter-house is made good from the fund. This would be a fair system if the vendors of animals also subscribed, but it is only paying out of one pocket into the other when butchers alone found the fund. It pleases some people to talk of the loss from contagious diseases animals as "a trade risk," and of insuran by butchers against it as a thing quite ana gous to insurance by shipowners. This arg ment takes no notice of an extremely importa difference. No regulations, either volunta or legislative, will ever put a stop to stor and accidents at sea. They are an inevital trade risk which cannot be suppressed, a can only be insured against. With contagio diseases of animals there is no such inevitab and unpreventable condition. The same arg ment prevailed for a time when the cattl plague invaded this country in 1865 — t disease spread, herds were exterminated, a stock-owners ruined. Then stamping out wi liberal compensation was tried, and in a f months the plague was exterminated. Simil measures have been attended with success the case of two other serious diseases—pleur pneumonia and foot and mouth disease. Co tagious diseases of animals are more than trade risk, they are a national disaster, a should be faced as such. They are preventab and, in time, extinguishable. By man's igno ance disease has been allowed to spread—b man's knowledge it can be controlled. All class may well be called on to share the expense suppressing a widespread disease, if it can b shown that it is a public danger, and can b controlled at a reasonable cost, and within reasonable time. The butcher, the cowkeepe and the agriculturist must all be called upo to use due care, and to put up with som unavoidable loss, but the public may also b logically included among those who pay th cost of legislative measures beneficial to all.

VOLUNTARY EFFORT *plus* INSPECTION O MEAT AND MILK.

Those who would rely upon voluntary effo for the control of tuberculosis in animals, ove look the danger to human beings, and trea with too little gravity the constant infection man which results from disease in cattl This danger received recognition when, i 1896, a Royal Commission was appointed "t enquire what legislative procedures are advis able, and would be desirable, for controllin the danger to man through the use as food o the meat and milk of tuberculous animals. This Commission issued a report in 1898 whic recommended :—

(1) That local authorities should hav powers given them to erect publi slaughter-houses, and provide for th inspection of meat.

(2) That the Local Government Board be empowered to issue instructions prescribing the degrees of infection which cause a carcase to be seized in whole or in part.

(3) That notification by the owner of every disease of the udder of cows should be made compulsory.

(4) That milk should be analysed and tested.

(5) That cowsheds should be kept in proper sanitary condition.

(6) That the Board of Agriculture should assist stock-owners to detect disease in their animals by the offer of a gratuitous tuberculin test, under conditions that compel separation and isolation of all diseased animals.

These authoritative recommendations are a ry great advance upon mere voluntary efforts. ıe regulations applying to butchers and cowepers are stringent, especially the one reiiring notification of all udder diseases. Even e gratuitous tuberculin test is made subject to nditions of separation and isolation equal any similar regulations now applied to her diseases under the Animals Diseases ct.

It will be noticed that the Commission was nited by its instructions to the question of otecting human beings from the danger of berculosis in animals. It, therefore, made suggestions for the control of the disease cattle except such as would indirectly llow voluntary efforts on the part of stockvners, and the conditional use of tuberculin the Board of Agriculture. The fact is the ommission could do no more, and their port is to be looked upon as the irreducible inimum of necessary legislation for saving ıman life. I shall try to show that their structions so limited their view of the subject to render it insufficient for any useful legistion, and that what they desire to attain can more easily and certainly arrived at by a ifferent course — by a course that will not ıly protect man, but will also assist the griculturist, and do justice to the cowkeeper nd butcher. The report of the Commission ertainly did good by directing public attention the subject, but its suggestion for compulory interference without payment of compenıtion has alienated many of the interests oncerned. By a majority of one the Comission decided against payment of compenıtion to the butchers for seizure of tuberculous arcases. Thus, by one man's vote, the meat trade has been made to take a position of opposition to proposed legislation, and the agriculturist has accepted the no-compensation verdict as an authoritative hint of what he may expect should he assent to any administrative action.

Legislative Control.

To know what authoritative opinion on tuberculosis in animals is, we must read with the report of the 1898 Commission, the recommendations of a Departmental Committee, which took evidence in 1888, on the question of measures required to control the disease in animals. It reported :—" That in order to ensure the gradual extirpation of tuberculosis, we are of opinion that it should be included in the Contagious Diseases (Animals) Act for the purposes of :—

(1) Slaughter of diseased animals.

(2) Payment of compensation for slaughter.

(3) Seizure of diseased animals in fairs and markets, or during transit.

Reading these recommendations in conjunction with those of the recent Royal Commission we obtain guidance as to the necessary measures for the protection of man and animals. The two objects are not separable. The control of tuberculosis in animals and in man is one subject, and unless the double object be kept in view administrative measures will be partially applied, insufficient, and unsuccessful.

I am supported in this contention by the report of the Royal Commission, which clearly recognised the insufficiency of its recommendations, and says: "All precautions against the communication of tubercular disease to human beings (from the consumption of meat or milk of diseased animals) must be regarded as temporary and uncertain palliatives, so long as no attempt is made to reduce the disease among the animals themselves." This sentence is the keynote to useful legislation. To protect man against a contagious disease of animals the logical plan is to control infection at its source—" to reduce the disease among the animals themselves." A good illustration of how this can be done is afforded by the success which has attended Mr. Walter Long's well-sustained effort against rabies in dogs—with the consequent disappearance of hydrophobia in man.

To protect human life against tuberculous meat and milk it is not sufficient to wait until disease has so nearly reached its goal, as when it is in the hands of butchers and cow-

keepers. Safety requires that the first effort should be to prevent it ever arriving so near the human stomach.

Looking at the control of tuberculosis in animals from the wider standpoint, we may find guidance in the combined recommendations of the two bodies who have taken evidence on the whole subject—on its danger to man and its danger to animals. If we place alongside of each other the reports of the Departmental Committee of 1888 and the Royal Commission of 1898, it will be seen how they are complementary to each other, and how the two must be jointly adopted to give the greatest amount of success with the least friction and cost.

The recommendations are :—

Departmental Committee.	*Royal Commission.*
Scheduling the disease in the Animals Diseases Act.	Compulsory notification by owners of all udder disease in cows.
Inspection of diseased animals.	Inspection of meat, milk, and cow-sheds.
Seizure of diseased animals in markets or during transit.	Seizure of diseased cows in slaughter-houses and cow-sheds.
Slaughter of diseased animals on owners' premises, and payment of compensation.	Voluntary use of tuberculin, but followed by isolation of all infected animals.

The Committee offer no suggestions for the protection of man from tuberculous meat and milk. The Commission leave untouched the mass of disease existing among all the stock not in the hands of butchers and cowkeepers. The defects of either recommendation would be eliminated by the adoption of both. I will very briefly consider each of these authoritative recommendations, and I may possibly show how some may be modified or extended.

Scheduling Tuberculosis in the Animals Diseases Act.—The first step in providing for legislative control of a disease in animals is to schedule it. When scheduled it becomes "a disease" under the Act, and further provisions may be added. That tuberculosis should be scheduled is the opinion of the whole veterinary profession. It was recommended by the Departmental Committee 11 years ago. This step need not be accompanied by any further regulations to do inestimable good. At present the regulation of cow-sheds depends chiefly upon the Cow-sheds' and Dairies' Order, one clause of which refers to the "Existence of disease among cattle," and provides that "if at any time disease exists among the cattle in a dairy or cow-shed . . . . . the milk of a diseased c therein shall not be used for human foo This would seem to afford all the protect necessary against tuberculosis. But the cla is a useless one, because the Act does define tuberculosis as "a disease." Two three other affections of cows which are transmissible or dangerous to man "diseases," and the milk from such anim must not be sold. The greatest danger to n from animal disease is tuberculosis, but thi untouched by the Cow-sheds' and Milk-sho Order. If the Board of Agriculture were schedule tuberculosis under the Anim Diseases Act, no diseased cow could rem in a shed supplying milk for human c sumption. Here is the means for the p tection of man ready at hand — a stroke the pen could bring it into action—but t Board of Agriculture make no move, whi 70,000 deaths from tuberculosis are register annually. Such fatuous indifference is in plicable. If tuberculosis were scheduled un the Animals Diseases Act nothing more wou be required to enable the medical officer health to guard human beings against tubercle-polluted milk supply.

This first step could be made without i posing on agriculturists the slightest restrai without interfering in the smallest degree wi healthy stock, or with any diseased anim outside of a cow-shed. Great as would be t good attained by merely making tuberculo "a disease" under the Animals Diseases A I should not propose to limit the action of t Board of Agriculture to this one essential ste There are regulations which must be enforc for the protection of animals as well as f man.

Notification of Udder Disease in Cows. One of the recommendations of the Roy Commission is that compulsory notification the owner of all udder disease in milk co should be enforced. This is very necessar because official inspectors cannot attend eve day, and udder infection must be detected the initial stage. The disease developes rapid and requires attention at the earliest possib moment if contamination of milk is to b prevented. The owner and his servants ha daily opportunity to detect anything amis and they therefore may well be required notify the danger immediately it is discovere As I have said before, the Royal Commissi cut down their recommendations to the irr ducible minimum. Had they not done so the would never have insisted upon the notificati

udder disease, whilst leaving unnoticed eralised tuberculosis, which may not affect udder, but which implicates every other t of the body. Cows suffering from ieralised tuberculosis are quite as common :ow-sheds as those affected with tuberculous lers. From them there is a constant escape tubercle bacilli in the excreta and in the itum. The front of the stall in which such vs stand is plastered with half-masticated d, mucus and sputum, whilst the tail l udder of the animal are fouled by the :illus-laden excreta. Even for human safety, ieralised cases of tuberculosis in cow-sheds ould be included with udder disease for :ification. When we take a wider view and ant that some control of disease among imals themselves should be enforced, the estion arises why disease should be notified cows and not in oxen? If compulsory tification of disease in one gland and one imal is advisable, why not extend the require-nt to include all clearly distinguishable bercular disease in cattle? No disease has er been scheduled in the Animals Diseases :t without compulsory notification being e very first regulation enforced. Curiously ough the Departmental Committee of 1888 clined to recommend compulsory notifica-n. The reason they gave for this omission is, "That the disease might exist and yet ow no signs of its presence." The difficulty diagnosis existed in 1888, but tuberculin has w rendered it possible to diagnose every se. The reason which ruled the committee longer exists, and we may infer there is no her objection to compulsory notification. it even in 1888 the recommendation of the mmittee was inconsistent with the course lopted with other contagious diseases. undreds of cases of pleuro-pneumonia in ttle and of glanders in horses then existed ith no sign of their presence. Those two seases required compulsory notification by e owner, under pain of fine or imprisonment r neglect; but of course no man was ever inished for not notifying a case he could not etect. No one now proposes to ask owners stock to do impossibilities and no one pro-oses to seize or slaughter those cases which in only be detected by the aid of tuberculin. Vhat is necessary is the notification of clearly iseased animals in cow-sheds or wherever iey exist.

Inspection of Meat, Milk, and Cow-sheds. -The danger from meat is not so urgent as that from milk. If local authorities put in force all the powers they possess, very little harm from tuberculosis in animals would result from meat. The worst meat is now smuggled into shops, evasion of inspection is deliberately carried out, and no respectable butcher has anything to do with it. The most effective method of protecting the public against such meat is not by expensive abattoirs and an army of inspectors, but by making it worth the while of the owner of stock not to sell diseased animals, but to report their existence to the authorities, who would then seize and compensate. Another method of protecting the public is to enable the butcher to protect himself from loss by giving him a claim on the man who sold him a diseased animal. So far as tuberculosis goes, the whole danger of infected meat would be better controlled by scheduling the disease in the Animals Disease Act than by any other course.

As to milk, the Royal Commission propose inspecting and testing. Every precaution and every check would be placed on tuberculous milk by the action of the Cow-sheds' and Dairies' Order provided its regulations were made potential by the inclusion of Tuberculosis in the Animals Diseases Act.

The inspection of cow-sheds is now under-taken by sanitary officers and medical officers of health. All that the Royal Com-mission require further is the inspection of the cows by veterinary surgeons. This also would be effected if tuberculosis were scheduled. The inspection suggested by the Royal Com-mission is of course useless unless provision be made for seizing and removing diseased cows.

Slaughter of Diseased Animals.—The Royal Commission said nothing of the seizure and slaughter of diseased animals, but those measures are implied by their recommendations for inspection of milk, and for notification of udder diseases. It is evident that the dis-covery of diseased animals would be useless unless they were removed. To compel a dairyman to kill diseased cattle at his own cost by stopping his business until he did so, would be an indirect meanness without pre-cedent. I conclude the Royal Commission would wish local authorities to have power to remove and slaughter all dangerous animals in cow-sheds. The Departmental Committee unanimously advised slaughter of diseased animals and payment of compensation. Here again we see that if the Board of Agriculture would schedule tuberculosis, and deal with it

as they have dealt with other contagious diseases, they would only be adopting what the Royal Commission and the Departmental Committee both recommend.

Compensation for Slaughter.—It is hardly necessary to offer any argument in favour of paying compensation to an owner for the seizure of his property for the public good. For more than thirty years the precedent has obtained of paying compensation for the slaughter of animals under the Animals Diseases Act. That a new departure should be made in the case of tuberculosis requires some reasons stronger than have yet been formulated. The owners of animals have been taught by previous experience to look to Government for assistance as well as for measures of confiscation. Authorities have found it easier, more effective, and less expensive, to pay the owner for his co-operation in notifying disease and isolating infectious animals than to refuse compensation whilst trusting to constant inspection and compulsion for the detection and control of disease. Liberal compensation has been found by the Privy Council and by the Board of Agriculture a necessary and expedient corollary of the compulsory slaughter of animals. Compensation is of course only partial, and the owner of stock is always a heavy loser, even when he receives the most liberal compensation.

Seizure of Diseased Animals.—This was advised by the Departmental Committee whenever animals were in such a position as to be likely to spread disease to other animals, as at fairs and markets, or on roads or during transit. The Royal Commission would only advise seizure where danger to man existed. If we are to avoid limiting preventive efforts to what the Commission called "temporary and uncertain palliatives," seizure of all diseased animals likely to injure man or spread disease, should be adopted. Power to seize animals away from home pre-supposes some regulations against movement of diseased cattle, and such regulations have always formed part of any scheme for the suppression of scheduled diseases.

Use of Tuberculin.—I accept as most valuable the recommendation of the Royal Commission that the Board of Agriculture should supply to any stock-owner who desired it a gratuitous testing of his stock. As the acceptance of the test is purely a voluntary act, the stock-owner cannot object to conditions that he shall separate all the diseased from the healthy and not sell those which are infected except for slaughter. These conditions though fair are likely to be so troublesome to many stock-owners, that I fear little request for the tuberculin test would follow its establishment by the Board of Agriculture. Cow-keepers would be well-advised to accept it if the opportunity occurs, still more willingly should breeders hold out their hand for it. The voluntary use of tuberculin, whether the test be applied by authorities, or by private veterinary surgeons, puts the owner in a position of command over the disease. He learns which animals are diseased and is able to separate them from the healthy stock and so prevent further spread of the plague.

The compulsory use of tuberculin should be provided for in some cases if the recommendations of the Royal Commission or of the Departmental Committee are given practical effect to. The cases I refer to are those where the inspector is doubtful as to his diagnosis. These doubtful cases have always been a source of trouble, and half the quarrels of stock-owners and the officials carrying out the provisions of the Animals Diseases Act, are traceable to disputed diagnosis with consequent delay in action and increase of trouble and cost. Tuberculin would assist to a correct diagnosis in a few hours. Udder diseases are many, and to differentiate every case of tubercular disease from induration due to non-specific causes is impossible. Tuberculin produces a local reaction in all affected organs, and so renders diagnosis of tubercular udder disease certain.

The various measures I have now discussed have all been recommended either by the Royal Commission as necessary to protect man from danger, or by the Departmental Committee to control disease among stock. The Government has ordered two select bodies to take the best evidence they could obtain and then to report what they considered necessary for the control of tuberculosis in animals. These authoritative bodies have reported, and from their published recommendations we may safely compile a complete scheme. It would be as follows:—

Tuberculosis to be scheduled in the Animals Diseases Act.

Compulsory notification to be enforced.

Inspection of meat, milk, and cow sheds to be carried out.

Movement of diseased animals to be regulated.

Slaughter of visibly diseased animals to be enforced.

Compensation to be paid to owner for slaughter.

Seizure of diseased animals in markets or duriug transit.

Power to use tuberculin in doubtful cases to to be given to authorities.

Offer of gratuitous tuberculin test to all stock owners, subject to isolation of all infected animals.

Our administrators know perfectly well what their trusted advisers have said, and what ought to be done. The loss from tuberculosis is 70,000 persons and 40,000 cattle every year. Is this not sufficiently serious to demand action? It would be absurd to suppose there was any doubt. Legislation is inevitable, and it must follow the lines sketched by the authorities I have quoted. The hesitation of Government to adopt legislative interference is due simply to fear of movement until the public, or a majority, are convinced of the necessity. The public are being rapidly educated. The trade interests most directly concerned will do well not to assume indifference, but to take an active part in promoting the public weal, at the same time that they defend themselves against any injustice.

There is one question that all sensible men endeavour to answer before commencing any scheme, viz.,—what will it cost? The control of tuberculosis among animals is not a small matter and no scheme of legislation with this object has the slightest chance of adoption by a Government department until the heads are satisfied of a probability of success, commensurate with the cost.

The State of Massachussets and the Kingdom of Belgium have shown by failure the impossibility of stamping out the disease by such radical measures as have been successful with some other animal plagues. If we accept the estimate that 20 per cent. of 4,500,000 of cattle are infected, and then assert that all these animals must be slaughtered and partially paid for, we enter on an undertaking that neither the owner of stock nor the taxpayer would approve. There is no necessity for such wholesale slaughter. The majority of infected cattle are not infective to others—they are neither dangerous to man or other animals, and their slaughter would be a wicked waste. Only the visibly affected are dangerous, and their number does not exceed 40,000. This estimate would include every animal whose carcase is wholly unfit for human food and every cow whose milk is unfit for consumption. The slaughter of these would be a loss to the owners, but it would be a public benefit, and it is expedient and just that the public should share the loss.

I suggest that local authorities should pay as compensation £2 per head for all compulsorily slaughtered of a value not exceeding £8; and a sum equal to one-fourth the market value of all others seized—but no animal should be valued at over £24. Any salvage on carcases, minus the cost of removal and slaughter, should be repaid to the owner.

The payment of £2 as compensation for miserable animals that are a danger to man or to other stock may seem an illogical proceeding, but unless some such inducement is offered, many of them would be sold to the lowest class of butcher and find their way into human food. A payment of £2 per head would make it worth the while of the owner not to evade reporting to the authorities, and so the existence of disease would become known with greater expedition. Infected premises once recognised could be supervised in such a way as to assist the owner and protect the public.

The difficulty of doing justice to the butcher might be met in another way. In any Act of Parliament dealing with the subject a clause might be inserted enforcing a warranty by the vendor of freedom from tuberculosis, whenever a butcher bought cattle and distinctly stated he was buying for the purpose of slaughter for human consumption. Such a clause would take from the butcher any claim for compensation, would protect the public by eliminating any reason for hiding disease, and would lay the burden upon his seller who is able to protect himself by testing the stock before going to market. This compulsory warranty would be limited to a period of eight or ten days.

The Royal Commission used as an argument against the payment of compensation, the evidence given it that butchers very seldom had much loss, and that the few cases occurring might easily be met by mutual insurance. If the argument has any basis, the fact may be used to show how slight the burden of my proposed warranty would be on stock vendors. The breeders and feeders are certainly more to blame for disease and its non-detection than butchers; they should, therefore, be held more responsible. By eliminating the butcher's claim for compensation measures of control are simplified because we then may deal with all stock and all claims under the Animals Diseases Act, which would provide assistance to the owners of stock, and compensation for all notified disease.

Compensation at the rate of £2 for all animals below the value of £8, and compensation at a higher rate on all over that value would probably reach a cost of £100,000 in the first year and a constantly decreasing sum every year afterwards until no disease existed. This is less than is now paid every year for the attempts to stamp-out swine fever.

For this payment, what should we receive? A guarantee against human infection from animals, and a gradual but rapid suppression of disease among stock.

I have now laid before you arguments in favour of legislative action. I have shown what danger and loss the disease causes. I have offered an estimate of the probable cost of proper control.

I hope I have been able to prove that voluntary effort is insufficient, and that the protection of human life will be most effectively undertaken by measures which apply to all animals, and not to those only which are in the hands of butchers and cowkeepers. The cheapest and best method is the one which is effective; the most costly is that which the Royal Commission well described as "temporary and uncertain palliatives."

DISCUSSION.

The CHAIRMAN said they were very much indebted to Mr. Hunting for throwing the light of his special knowledge and experience on a question which it was quite evident was one of national importance. Figures were apt to slip from one's mind without producing much impression, unless they were connected with something tangible, and when reference was made to the fact that 70,000 deaths occurred annually from tuberculosis, it occurred to him that there were scattered over the country a considerable number of flourishing market towns, having a population of from six to ten thousand; if, then, they considered that the whole population of something like ten of such towns was annually swept away by this plague. it would give a more realistic idea of the magnitude of the evil. Everything which brought home the facts to the public mind was a great benefit. Not long since, England might be said to be in the van of sanitary science, but of late years she had somewhat lost that position, and had been outstripped by other countries, the reason being that the rulers of those countries, acting under the best scientific advice, had become prone to take the initiative and to introduce legislation, which was not only effective, but also educational. Our rulers would do nothing in such matters until they were forced on by public opinion, and therefore the sooner that public opinion was formed on the best possible data, the better it would be for all. He would ask if it were not a slight exaggeration to say that milk must be well boiled to render it safe, because he was under the impression that Dr. Klein had stated that raising it to 150° Fahr. and then cooling it, was sufficient, and that temperature did not spoil the flavour of the milk or render it less digestible, as boiling did. That it ought to be protected in some such way in the household, pending the time when it would be protected by statute, was clearly shown by an interesting report published in the *Lancet* a fortnight ago, of some researches made by Dr. Sladen, of Cambridge, under the supervision of the late Professor Kanthack. Search was made for the presence of the tubercular bacillus in the milk supplied to the colleges at Cambridge, and, out of sixteen samples, nine were found so actively infective that they caused the death in a few weeks of guinea pigs, under whose skin a few drops were injected; and the creamy layer at the top and the sediment at the bottom of the vessel were found equally fatal. All those samples were, no doubt, supplied by tradesmen of good position. Similar researches in Berlin and elsewhere had shown an abundance of these same bacilli in butter, and it must be remembered that milk was an admirable cultivating medium for the bacillus, so that when the milk from one cow with a diseased udder was mixed with that from healthy animals, the bacilli would multiply at an almost incredible rate, and the whole milk would be quickly contaminated. He had listened with great interest to the remarks on the question of compensation, which was clearly one which would have to be faced, and on which it was quite possible to entertain different views. He had heard of a district in India where a premium was paid for every poisonous snake which was destroyed; there was a man in the neighbourhood who called himself a hunter of snakes, and he brought in a great number every year, for which he was duly paid, until at length it was discovered that he had a small snake farm and bred them, killing and bringing in to the public officer as many every year as he thought would pass muster. Was there not a possibility that under a system of compensation it might become a business to deal in tuberculous cattle.

Professor PENBERTHY said he cordially agreed with the greater part of Mr. Hunting's remarks. He had shown how great was the danger, and also that it was preventable. Sixteen years ago a paper on the same subject was read in that room at the first meeting of the National Veterinary Society, when the same recommendations were resolved upon, and made public as far as possible; but they were then impracticable of application, because they had at that time no certain means of discovering the disease. That power had now been obtained, and they could at any time discover how many animals were affected, and it was also now thoroughly recognised that the disease in human subjects was to a large extent derived from animals. Only that morning he had

received a letter from Jersey pointing out that the disease was almost non-existent amongst cattle in the Channel Islands, and at the same time the Registrar-General's returns showed that the diseases of children due to tuberculous milk were almost unknown. There ought to be a grand effort made to stamp out this great enemy which had destroyed during the present reign more lives than all the wars of Great Britain during the last 1,000 years. Even if it cost £200,000, it was not the price of one battleship, and it ought not to be taken into consideration. It was an advantage to the farmer to discover, if he could voluntarily, what animals were affected, and at once deal with them to the best advantage, and this, to some extent, would be a protection to human health. But the elimination of tuberculosis in the lower animals could scarcely be compared with the eradication of pleuro-pneumonia or cattle plague. The latter diseases were only communicable from one animal to another, while tuberculosis affected not only cattle and human beings, but a large number of other animals: rabbits, pigs, fowls, and horses, to a certain extent. Moreover, though the plan proposed would have a good effect, he doubted whether it could secure the extirpation of the disease. The case of other animals must also be dealt with. The education of public opinion, whether legislation followed or not, would act with very great force in reducing the danger to the public. The knowledge that this disease existed in more than 20 per cent. of our cattle had already produced a considerable effect on stock owners, though the matter had only been before the public for a short time. Already 20 corporations were applying their powers to the question; and he could say from his own knowledge that between 4,000 and 5,000 animals had been tested with tuberculin, and that was probably only a small proportion of those which had been so treated. It was absolutely necessary, however, that the Legislature should take the matter up seriously, and whatever money was required, he could not see why it should be refused. No doubt the reports of the Royal Commission had gone a little further than their instructions warranted, and indirectly they had considered the difficulties of eradicating tuberculosis. A very large number of animals would have to be dealt with immediately, and the dairies could not be readily restocked, but that should not be urged as a reason for neglecting the matter. He hoped that the publication of this paper would have a very material effect in the education of public opinion.

Mr. LOVEJOY asked if some suggestions could not be made to the Board of Agriculture to offer facilities for applying the tuberculin test gratuitously. Every breeder would rather produce a healthy animal than an unsound one, and he should think they would all be glad to avail themselves of this method of diagnosis.

Dr. A. GASTER remarked that if all the tuberculous animals in England were destroyed, it would not prevent infection by milk coming from abroad. Meat was much more easy to deal with, and in most cases the bacilli were not found in the muscle but in the lymphatic glands and in the lungs, which were not used as human food; neither did people eat meat raw, and if the bacilli were killed at a temperature of 150° Fahr. they would hardly survive ordinary cooking. In the case of milk, there was no possible test, except by experiment on rabbits or guinea-pigs, and therefore people ought to boil their milk. While they were trying to stamp out tuberculosis in cattle, they must not forget that the disease existed in thousands of human beings, by whom it was spread, and also in other animals, rabbits, and particularly in fowls. All meat should be inspected, and, of course, compensation should be paid to those whose cattle were destroyed for the good of the public.

Mr. PRAED asked how the tuberculin test acted.

Colonel BURKE asked how much of the mortality of 70,000 annually was due to infection from animals; also, how it was proposed to deal with animals which were only slightly affected.

Mr. EDWARD C. DE SEGUNDO said people often made the remark that their fathers and mothers drank milk and got no harm by it, and why could not we do the same; but, as a matter of fact, the statistics given by Sir Richard Thorne Thorne in his last Harveian lecture showed how worthless that argument was. The mortality amongst adults from tubercular disease had greatly diminished, owing to improved sanitation and so on, but infant mortality from *tabes mesenterica* had increased very largely, and he attributed that to a great extent to the importation of milk and butter from foreign countries. In this country inspection was carried out to a certain extent, but on the Continent there was no such control over the dairies, and the frozen milk and butter sent here might be infected to any extent with the tubercle bacillus. The Chairman had drawn attention to the rapidity with which this bacillus multiplied in milk, and he should like to emphasise that by quoting some figures from an article entitled "microbes in milk," which appeared in *Chambers' Journal* of August last. It appeared from some experiments made by Professor Freudeurich at Berne, that a quarter of a cubic inch of milk, which contained 9,000 microbes, seven hours later contained 80,000, and 25 hours later 5,000,000; while, if the temperature were raised to 95° Fahr., about blood heat, the population of the same milk in the same time would reach 812,000,000 — to follow the Chairman's illustration, equivalent to a thriving market town of 10,000 inhabitants becoming in 25 hours nearly 200 Londons. Nothing could be more clear and convincing than the arguments brought forward in this paper, and it was perfectly incomprehensible how the subject had been allowed to remain dormant so long. However, if the wheels of legislation ground slowly, they must hope they would grind exceeding small. He would now refer to

a process which might be called only a palliative, bnt from a practical point of view had a good deal to recommend it, viz., the sterilization of milk, which, as an engineer, he had to investigate some four years ago. One important question, of course, was that of the cost, and he quite agreed with Mr. Hunting that people would not pay a higher price for pure milk. But they need not do so. By placing the matter under control of the Municipality it would be possible to sterilize all the milk sent up from the country and to distribute it, in sealed glass bottles, absolutely free from any germs at 4d. per quart without causing any burden on the rates. He was speaking with an intimate knowledge of what was at present being done in this direction in London on a commercial scale. In this way something could be done to diminish the number of victims of infected milk (particularly among children), until the recommendations contained in Mr. Hunting's admirable paper could be carried into effect and the disease stamped out, at least as far as cows are concerned.

Professor LONG said this paper was one of the best he had heard on this subject, and he wished the author would come to one of the monthly meetings of the Central Chamber of Agriculture which were held in that room, and address the farmers upon it. The last speaker had referred to the number of bacilli present in a given quantity of milk, but they must not go away under the impression that those were all disease germs, because they were not ; the majority of them were friendly germs, which were useful not only in the milk, but also in the body of a human being. With regard to the importation of milk from abroad, he might say that large quantities were being imported at Southampton from parts of France where disease was known to be rife amongst the cattle. With regard to butter he did not think there was so much danger as might be supposed. Cream was nowadays mostly obtained by means of a separator, in which the cream was gathered in the centre, and experiment showed that the bacteria were to a large extent thrown to the periphery of the drum. This had been clearly established in Massachusetts. At any rate, with regard to butter, it might be obtained from the West of England, where the cream was scalded, or from Ireland, where it was produced on the Danish or Swedish system, under which the whole of the cream or milk was Pasteurised, and the disease germs destroyed; and not only the disease germs, but all others. Now it was essential to good butter that there should be some germs present, and, therefore in these factories the superintendent added a small portion of "starter," which was a pure culture of the butter germ, and this set up the acid process necessary to the production of good butter. The only germs present, therefore, were those thus introduced, which were innocuous. Personally, he had suffered severely from the presence of tuberculosis in cattle, and had made various investigations, but nothing seemed to stop it. He had sold and kill[...] great many animals, and yet the disease would b[...] out again in an apparently healthy beast. The Corp[...] tion of Glasgow had got a Bill passed giving t[...] power to follow any milk delivered in the city t[...] source, and if they found a diseased cow in the d[...] he believed they could order it to be destro[...] Those powers had not been put in force, but [...] Hunting said there were twenty different corporat[...] seeking for similar powers. He should object to [...] strongly, though he should quite agree that po[...] rather more limited might be conferred. They sh[...] have power to trace the milk, and if a cow were fo[...] with a diseased udder, or with generalised tu[...] culosis, it should be destroyed, but not any other c[...]

Mr. HUNTING, in reply, said that whatever meas[...] were applied to producers of milk in this cou[...] should equally apply to milk imported from abr[...] It was not very easy to say exactly what should [...] done. All meat affected by tuberculosis should [...] seized, but it was not so easy to deal with m[...] There was no immediate method of testing it; if [...] inoculated a guinea-pig you had to wait some t[...] for the development, and in the meantime the [...] was gone, and the next lot of milk might be innoc[...] If one source of milk were clearly shown to [...] tainted, you must forbid further importation from [...] same source, but he feared the commercial inst[...] would get round such prohibition by sending i[...] another port. Measures for protecting the health [...] human beings were not at all antagonistic to meas[...] dealing with animals, and, in the latter case, c[...] pulsory regulations were much more easily appli[...] as no conscience clause was allowed to interv[...] He understood the Board of Agriculture was sim[...] waiting for an application to be made to it w[...] regard to the tuberculin test. Mr. Walter L[...] recently said that no public body had yet asked fo[...] but if it did, he saw no reason why he should [...] apply to the Treasury. The Royal Commission [...] suggested the expenditure of £5,000, which Mr. L[...] said was a small matter. He quite agreed with [...] Penberthy that you could not compare this dis[...] with cattle plague, or pleuro-pneumonia, and s[...] officials of the Board of Agriculture said the same th[...] meaning that they could not do anything under [...] Animal Diseases Act. But it could be compared w[...] some of the other diseases dealt with in that [...] notably with one, to which it was in many w[...] analogous, viz., glanders in horses. That dis[...] might lie latent for months, and the regulations [...] applied to glanders might very well be applied [...] tuberculosis. If the authorities seized a horse w[...] 80 guineas, and gave the owner £2, a farmer wo[...] not have much to complain of if they seized a c[...] worth £10, and gave him £2 for that. The effec[...] tuberculin was this: when injected into an unheal[...] animal it raised the temperature 3 or 4 degrees, [...] effect being most marked at the thirteenth hour. [...] also affected any local disease which might exist. [...]

were tuberculosis of the lungs, it would set animal coughing; if the intestines were ed, it would produce diarrhœa for a little ·; if the udder were affected, it would : some pain and heat in the indurated por- Unfortunately, however, it did not tell you mount of tuberculous disease in the animal. It d produce as great a reaction if the animal had or three portions of tubercular matter the size of , as if the whole of the lungs or abdomen were ted. That must be borne in mind in considering : to do with the animal. All lean stock that :ed should be isolated until fit for the butcher; ding stock should be kept separate, as long as did not "waste," and were likely to throw a good Milking cows must still be milked, because the may be perfectly innocent; but the udder should arefully examined from day to day, and on the ıtest sign of enlargement or disease, the milk should topped. If Dr. Klein said 150° Fahr. was suffi- t to make the milk safe, he should be sorry to it was not; but the ordinary housekeeper knew ıing about a thermometer, and the simplest ce was to boil the milk. He did not know how y of the 70,000 deaths were attributable to ıals, but if they were only 7,000, or 700, or even and you could certainly prevent them, would it be well worth doing? With regard to the irman's suggestion about the snake farm, he ht say that Dr. Legge, the late Secretary of the ·al Commission, made a similar remark, that ıpensation would open the door to fraud, but any who had anything to do with compensation er the Animals Diseases Act knew there was ıing in it. Feeding snakes was probably not · expensive, and the capital required was not e, but the feeding of cows costs money, and ·ing tuberculous cows and keeping them even a ·k in the hope of getting £2 for them would not be ery tempting speculation. As an official who ;ht have something to say to that question, he uld say the very best thing which could happen ıld be for some one to speculate in tuberculous :k. When that man had reported about four cases, uiries would be made where they came from, l the end would be that instead of making a profit would get locked up whilst he would be invalu- e as a voluntary detector of diseased herds.

The CHAIRMAN then proposed a cordial vote of nks to Mr. Hunting, which was carried unani- usly; and the meeting adjourned.

Miscellaneous.

INTERNAL TRAFFIC OF FOREIGN CITIES.

At the end of his Address at the Opening Meeting the Society (November 16), the Chairman of the Council, Sir John Wolfe Barry, referred to the valuable information which he had received through the Foreign-office, and from the Mayors of Washington, New York, and Boston, in answer to inquiries which he had made as to certain particulars relating to the means of communication in foreign cities. Viscount Gough, First Secretary to H.M.'s Embassy at Berlin, sent information relating to that city; the Burgomaster of Brussels, through H.M.'s Minister, supplied statistics respecting Brussels; Mr. Austin Lee, C.B., gave the particulars of Paris traffic; and Sir Horace Rumbold, Bart., G.C.M.G., Ambassador at Vienna, supplied information respecting that city.

The information received may be classified under the following headings:—(1) Daily number of persons entering or leaving the cities; (2) Particulars of traffic; (3) Number of vehicles at fixed points; (4) Width of streets.

1.—DAILY NUMBER OF PERSONS ENTERING OR LEAVING BERLIN, VIENNA, AND NEW YORK.

The average daily number of persons entering Berlin is stated to be about 150,000; but the daily ebb and flow of the population of the cities of Europe and of the United States do not appear to be available.

In 1896, 5,291,317 persons entered the city of Vienna by rail, or an average of about 14,500 daily.

In New York the average number of passengers daily crossing New York and Brooklyn-bridge, during 1897, is given as 138,473. The average number of vehicles daily crossing is 4,500.

	Passengers.	Vehicles.
November 10, 1897 (24 hours).	144.509	4,617
The highest number in one hour is from 3 to 6 p.m., viz.....	19,262	472
The lowest number, from 3 to 4 a.m., viz................	422	27

2.—MEANS OF TRAFFIC.

Berlin.—The annual working expenses for the passenger traffic in Berlin are given as follows:—

	£		£
Railways................	150,000	to	200,000
Tramways (including electric lines)...............	650,000	to	750,000
Omnibuses	200,000	to	250,000

Brussels.—In Brussels the number of different lines of tramways and railways, with the annual number of passengers, are as follows:—Tramways—Les Tramways Bruxellois, 16 lines (horse and 5 electric), number of travellers in 1896, 30,760,989; 1897, 39,304,795. Société Generale Chemins de fer économiques, 5 lines (horse), number of travellers in 1896, 3,146,300; 1897, 4,098,451 Société des Chemins de fer vicinaux, 1 line (horse), number of travellers in 1896, 910,360; 1897, 905,020. Société du Central Car, 1 line (horse), number of travellers in 1895, 796,149; 1896, 1,018,801; 1897, 1.445,195. Société du Tram Car, 1 line (horse), number of

travellers in 1896, 2,658,493; 1897, 2,806,330. Railways—Société de Chemins de fer à voie étroite, 5 lines (electric); Société Nationale des Chemins de fer vicinaux, 8 lines (7 steam, 1 electric), number of travellers in 1895, 1,687,737; 1896, 2,110,830; 1897, 2,303,881.

Paris.—In Paris the daily average of travellers from Paris to Auteuil and from Paris to Versailles is:—Railways—Paris-Auteuil, travellers going and returning, 63,000; fares, 1st class, 60c., second class, 30c. Versailles, by circular railway, passengers, 311,936; fare, 1 f. 16 c.

The annual movements by tramcars and steamboats are:—Tramways—(fares, 1st class, 40c., 2nd class, 20c.) St. Cloud and Sèvres, 3,141,244 passengers; Vincennes, 7,739,350 passengers; North, 29,887,943 passengers; South, 27,160,032 passengers. Boats—Paris to Suresnes, 2,545,745 passengers, fare, 30 c.

Vienna.—In Vienna there are no electric railways. A metropolitan railway is in course of construction, and 21 miles 223 yards are open to the public. Fares per kilometre—1st class, $3\frac{1}{4}$ kreutzers ($\frac{3}{4}$d.); 2nd class, $2\frac{1}{4}$ kreutzers ($\frac{1}{2}$d.); 3rd class, $1\frac{1}{2}$ kreutzers ($\frac{1}{4}$d.).

There are $35\frac{1}{2}$ miles of tramway lines and 738 tramcars, of which 70 are driven by electricity. The zone tariff is in force as follows:—5 kreutzers (1d.) from the 1st to the 2nd zone, 7 kreutzers ($1\frac{1}{2}$d) from the 1st to the 3rd zone, 10 kreutzers (2d.) from the 1st to the 4th zone, 15 kreutzers (3d.) from the 1st to the 5th zone, 20 kreutzers (4d.) from the 1st to the 6th zone; 2 kreutzers charged from 2nd to 3rd, 3 kreutzers from 3rd to 4th, &c.

The omnibuses number 520. Fares:—7, 9, 12, 15, kreutzers, according to distance. The zone tariff applies to omnibuses and to the metropolitan railway.

Of Hackney carriages there are (numbered) 972 with two horses, 1,514 with one horse, and (unnumbered) 1,298 with one and two horses. Fares, from one district to another, two-horse cab, 90 kreutzers (1s. 6d.), one-horse cab, 60 kreutzers (1s.); from one point to any other in the same district, two-horse, 60 kreutzers (1s.), one-horse 40 kreutzers (8d.); for every quarter of an hour beyond the ride, two-horse, 40 kreutzers (8d.), one-horse, 30 kreutzers (6d.); the same extra charges are made for coming from or going to railway stations, or for setting down at theatres.

New York.—The chief means of communication in New York consists of elevated railways, surface railroads, and steam ferries. Passengers carried on railroads for the year ending June 30, 1897, for the territory now comprising New York City, 862,552,517. Fare 5 cents for any distance. A passenger may make one continuous trip of 17 miles around the city on the Manhattan Elevated Railway for one fare of 5 cents.

Washington.—There are 180 miles of asphalt-paved streets in Washington, and the number of bicycles on these roads is given as 40,000. The average daily number of passengers carried by street railways (electric and cable) is 143.302. The fare for one adult passenger in the cars, with privilege of transfer[s] about $4\frac{1}{3}$ cents ($2\frac{1}{4}$d.).

The number of licensed public hack cabs and c[ar]riages in Washington is 441. The fares are divi[ded] into day rates (5 a.m. to 12.30 a.m.) and midni[ght] rates (12.30 a.m. to 5 a.m.) and are charged by [the] trip and by the hour. The fares for two-horse vehi[cles] are about double those for one-horse vehicles.

3.—Number of Vehicles at Fixed Point[s].

Berlin.—The points of greatest traffic (daily, 6 a[.m.] to 10 p.m.) are as follows;—

	Foot pas.	Vehicl[es]
Potsdamer Platz (west district)	85,580	16,51
Brandenburger Thor (west district)	70,600	9,25
Unter den Linden (corner of Friederich Strasse, west district)	120,800	13,24
König Strasse (corner of Spandauer Strasse, central district)	92,300	12,97
Alexander Platz (central district)	151,220	11,91
Belle Alliance Brücke (south-west district)	112,751	10,24
Oranien Brücke (south district)	98,680	7,84

Paris.—The average number of vehicles pass[ing] the Avenue de l'Opera during the 24 hours is 29,4[..], the vehicles being drawn by 36,185 horses.

Washington.—The number of vehicles passing [the] corner of Pennsylvania Avenue and Seventh-st[reet] (one of the most frequented points in the city) dur[ing] the 24 hours from 12 o'clock noon, Nov. 5, to [12] o'clock noon, Nov. 6, 1898, was 9,726. The num[ber] of passengers in the vehicles was 16,848.

4.—Width of Streets.

Berlin.—Unter den Linden (includes a broad w[alk] with two rows of trees for nearly half of the wh[ole] length), 196 ft.; Leipziger Strasse, 72 ft.; Fried[ri]n Strasse, 72 ft.; Friedrich Strasse, from the corne[r o]f Behren Strasse to Unter den Linden, 41 ft.; Kö[ni]g Strasse, 57 ft. The width of the pavements on b[oth] sides of the street is included.

Bruxelles.—Le Boulevard Circulaire, between [the] Places de Namur and Louise, 220 ft.; L'Ave[nue] Louise, 183 ft.; L'Avenue du Midi, 118 ft.; [L]e Boulevard Anspach, 91 ft.; Le Boulevard du No[rd], 78 ft.; Le Rue de la Nord, 65 ft.; Le Rue Roy[ale], 65 ft.

Paris.—Rue de Rivoli, 88 ft.; Rue Montmar[tre], 72 ft.; Avenue de l'Opera (Boulevard St. Germa[in]), 98 ft.; Grands Boulevards, 114 ft.; Avenue [des] Champs Elysées, 229 ft.; Avenue de Grande Arm[ée], 295 ft.; Avenue Bois de Boulogne, 393 ft.

Vienna.—Ringstrasse, 187 ft.; Kärntnerstra[sse] (Upper), 62 ft.; Kärntnerstrasse (Lower), 121 [ft.]; Praterstrasse, 118 ft.; Rennwegg, 65 ft.; Hau[pt]-strasse, 3rd and 4th district, 65 ft. each; Hau[pt]-strasse, 5th district, 72 ft.

York.—The streets vary in width from about t to 150 feet. The ordinary residence streets ing at First-street and extending across the of Manhattan from east to west, up as far as street are 60 feet wide, excepting at intervals ut half a mile, when they are 100 feet. The s which run north and west at right angles the cross streets are 80 to 150 feet wide. Houston-street or First-street, on Man- Island, the streets and thoroughfares are of ar widths, following for the most parts lines hs, lanes, or roadways originally followed for nience of the early colonists or settlers.

shington.—Most of the Avenues named after fferent States are 160 feet wide from building o building line, with 50 to 107 feet roadway tively.

Avenue.	Width.		Roadway.
Virginia..........	160 ft.	....	50 ft.
Maryland	160 ft.	....	50 ft.
Delaware	160 ft.	....	50 ft.
New Jersey	160 ft.	....	60 ft.
Pennsylvania......	160 ft.	....	$107\frac{1}{2}$ ft.
North Carolina....	160 ft.	....	50 ft.

Correspondence.

ANSMISSION OF ELECTRIC POWER.

attention has been drawn to Professor Forbes's ks under the above heading. (See *ante*, 03, 139.)

Professor Forbes will refer to pages 240 to 243 e Proceedings of the Manchester Association of neers, 1892, he will find my article "On the ncial risk involved in laying down long hs of Electric Conductors;" he will see that my osal, [*e.g.* "that the capital required to cover the of trunk transmission lines should be obtained he special issue of *mortgage debentures* at the of *interest* specified"] was the result of a some- elaborate investigation into the range of fluctua- of the value of copper—extending over the period years—or from 1877 to 1891.

ne average ratio of risk was compared with that ne bank rate of interest and also with that of ay and Government stock. The investigation led o fix on the figure of $3\frac{3}{10}$ per cent. as a fair mortgage nture rate of interest for a long distance trans- ion trunk line, *pure copper* conductors, laid down his country. A graphic diagram also accom- es my article and defines the average value of er (Chilian bar) during a period of 13 years.

lthough I cordially wish Professor Forbes every ible success in his African project, I doubt if the ncial world would encourage the investment of ey at even double that of the rate of interest gested.

B. H. THWAITE.

Great George-street, Westminster, S.W.,
January 11th, 1899.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 1.—"The Cost of Municipal Enterprise." By DIXON H. DAVIES. The ATTORNEY-GENERAL, G.C.M.G., M.P., will preside.

FEBRUARY 8.—"Nernst's Electric Lamp." By JAMES SWINBURNE.

FEBRUARY 15.—"The Balloon as an Instrument of Scientific Research." By the Rev. JOHN M. BACON, F.R.A.S.

FEBRUARY 22.—"Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

MARCH 1.—"Leadless Glazes." By WILTON P. RIX.

MARCH 8.—

MARCH 15.—"Liquid Fuel." By Sir MARCUS SAMUEL. Sir EDWYN S. DAWES, K.C.M.G., will preside.

Dates to be hereafter announced:—

"Preservation of Timber." By S. B. BOULTON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

"London's Water Supply." By WALTER HUNTER, M.Inst.C.E.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 9.—"The Penal System at the Andamans." By Colonel RICHARD CARNAC TEMPLE, C.I.E., Chief Commissioner of the Andaman and Nicobar Islands. The EARL OF NORTHBROOK, G.C.S.I., D.C.L., F.R.S., will preside.

MARCH 9.—"Leprosy in India." By H. A. ACWORTH, C.I.E., late Government Municipal Commissioner for the City of Bombay.

APRIL 13.—"Judicial Reforms in Egypt in Relation to the Indian Legal System." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive.

MAY 11.—"The Port of Calcutta." By SIR CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

MAY 25.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

The meetings of February 9, and March 9 will be held at the Imperial Institute; those of April 13, May 11 and 25 at the Society of Arts.

FOREIGN AND COLONIAL SECTION.

FEBRUARY 28.—"Persian Trade Routes." By A. HOTZ.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

January 31.—"The Centenary Exhibition of Lithographs, with remarks on further Developments of the Art." By Edward F. Strange. Major-Gen. Sir John Donnelly, K.C.B., will preside.

February 21.—"Vitreous Enamels." By Cyril Davenport. Sir Owen Roberts, M.A., D.C.L., will preside.

March 14.—"Craftsmanship and its Place in a National Scheme of Art Culture. By Sir William Blake Richmond, K.C.B., R.A.

April 18.—"Modern Changes in Taste relating to Domestic Furniture." By George Lock.

May 2.—"Maiolica." By William Burton.

May 30.—"Wrought Iron Signs." By J. Starkie Gardner, F.G.S.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Dr. Samuel Rideal, "Bacterial Purification of Sewage." Four Lectures.

Lecture III.—January 30.

Anaerobic preparation—Mouras' automatic scavenger—Moncrieff's earlier experiments—Exeter septic tank.

Lecture IV.—February 6.

Differentiation of the organisms—Scott Moncrieff's later process — Nitrification and nitrosification—Adeney's "oxygen system"—Conditions for aerobic and anaerobic change, and criteria for judging the purity of effluents—Resumé and suggestions.

Archibald Sharp, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures. February 20, 27, March 6, 13.

Prof. Henry R. Procter, "Leather Manufacture." Four Lectures. April 10, 17, 24, May 1.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Samuel Rideal, "Bacterial Purification of Sewage." (Lecture III.)

Imperial Institute, South Kensington, 8½ p.m. Miss M. H. Kingsley, "West Africa."

Actuaries, Staples-inn-hall, Holborn, 7 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Walter Raleigh, "Lord Chesterfield."

Tuesday, Jan. 31...SOCIETY OF ARTS, John-street. Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Edward F. Strange, "The Centenary Exhibition of Lithographs, with Remarks on Further Developments of the Art."

Royal Institution, Albemarle-street, W., 3 p.m. Professor E. Ray Lankester, "The Morphology of the Mollusca." (Lecture III.)

Civil Engineers, 25, Great George - street, S.W., 8 p.m. 1. Adjourned Discussion on papers by Mr. William G. Kirkaldy, "The Effects of Wear on Steel Rails," and Sir William Roberts-Austen, "The Microphotography of Steel Rails." 2. Mr. J. A. Jones, "The Waterworks of the Madras Presidency."

Colonial Inst., Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Miss Flora Shaw, "Canada."

Wednesday, Feb. 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Dixon H. D[illegible]s, "The Cost of Municipal Enterprise."

Geological, Burlington-house, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m. Annual Meeting.

Thursday, Feb. 2...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. E. Stanley Salmon, "Notes on the Genus Na[illegible]trium, Lindberg." 2. Dr. F. W. Stansfield, "The Production of Aposporg by Environment in [illegible]rium] Filix - foemina var. unco-glomeratum, an apparently barren fern." 3. Mr. Gilbert C. Bourne, "The Genus Lemnalia (Gray) with an Account of the Branching System of the Order Alcyonacea."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. H. T. Brown and Mr. J. H. Millar, (*a*) "Maltodextrin, its Oxidation, Products, and Constitution;" (*b*) "Attempts to prepare Pure Starch Derivatives through their Nitrates." 2. Professors H. Lloyd Snape and Arthur Brooke, "An Isomeride of Amarine." 3. Dr. G. T. Moody, "Propylbenzenesulphonic Acids." 4. Messrs. W. H. [illegible]ls and T. H. Basterfield. "Derivatives of Dibenzylmesitylene." 5. Dr. Sydney Young, "The Action of Chlorosulphonic Acid on the Paraffins and other Hydrocarbons." 6. Messrs. F. D. Chattaway and Kennedy J. P. Orton, "The Preparation and Properties of Nitrogen Iodide." 7. Messrs. F. D. Chattaway and H. P. Stevens, "The Action of Reducing Agents on Nitrogen Iodide." 8. Dr. F. D. Chattaway, "The Composition of Nitrogen Iodide." 9. Messrs. F. D. Chattaway and Kennedy J. P. Orton, (*a*) "The action of Light upon Nitrogen Iodide;" (*b*) "The action of Alkaline Hydrates, of Water, and of Hydrogen Peroxide upon Nitrogen Iodide." 10. Messrs. F. D. Chattaway and H. P. Stevens, "The action of Acids upon Nitrogen Iodide." 11. Messrs. F. D. Chattaway and Kennedy J. P. Orton, "Theory of the Formation and Reactions of Nitrogen Iodide."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. W. F. R. Welldon, "Worms."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. John Wilson, "The Sacred Lake of the Incas."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. H. Savage Landor, "Tibet and the Tibetans." (Lecture III.)

Friday, Feb. 3...Royal Institution, Abemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m. Mr. V[illegible] Horseley, "The Roman Defences of South-east Britain."

Geologists' Association, University College, W.C., 7½ p.m. Annual Meeting.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, Feb. 4...Education Department, Lecture Theatre, South Kensington Museum, S.W., 3½ p.m. (Lecture.) Dr. Lockyer, "Astronomical Instruments."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander C. Mackenzie, "Brahms." (With musical illustrations.)

Journal of the Society of Arts.

No. 2,411. Vol. XLVII.

FRIDAY, FEBRUARY 3, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ORDINARY MEETING.

The discussion on Mr. Dixon H. Davies's paper on "The Cost of Municipal Enterprise," read at the meeting on Wednesday evening, 1st inst., was adjourned to Thursday evening, 9th inst., at 8 p.m. The Earl of Wemyss will open the discussion.

CANTOR LECTURES.

On Monday evening, January 30, Dr. Samuel Rideal delivered the third lecture of his course on "Bacterial Purification of Sewage."

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, January 31st, 1899; Major-General Sir John F. D. Donnelly, K.C.B., Vice-President of the Society, in the chair.

The paper read was "The Senefelder Centenary Exhibition of Lithographs, 1898-99," by Edward F. Strange.

The paper and report of the discussion will be printed in the next number of the *Journal.*

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, January 24, 1899; The Hon. Sir David Tennant, K.C.M.G., Agent-General for Cape Colony, in the chair.

The paper read was—

RHODESIA AND ITS MINES IN 1898.

By William Fischer Wilkinson, F.G.S., Assoc. M.Inst.C.E.

Nearly three years have passed since I had the honour of contributing to the Society's *Journal* a paper on the gold mines of Rhodesia.* At that time, in 1895, the country was but little known, and the most extreme opinions were offered as to its resources; while some thought that it would become as large a producer of gold as the Transvaal, others again were equally confident that the country was nothing but a fever-stricken swamp, destitute of mines, and unfit for a white man to live in. Events march rapidly in Africa, and the question of interest is no longer whether or not payable gold reefs exist, but to what importance the mining industry is likely to attain. Having spent the greater part of last year (1898) in travelling about among the different mining districts, and having examined the most advanced mines, I shall endeavour to answer that question. In considering the progress that has been made in the last three years, it must be remembered that Rhodesia has had little time to devote to the peaceful development of her resources. What with the native rebellion and the rinderpest all work was practically stopped during 1896 and 1897, and it was not till 1898 that any real progress could be made. It is not my intention to trouble you much with statistics, but I want in the first place to draw your attention to the great size of the country, and to remind you that a large portion of it is still practically unexplored. At the present time the river Zambesi is the dividing line between the occupied and administered part of Rhodesia and the unoccupied portion, over which only a small show of authority has so far been made. Southern Rhodesia, which embraces the provinces of Matabeleland and Mashonaland, is about one-and-a-half times, and Northern Rhodesia is about twice, the area of Great Britain and Ireland, an enormous extent of country, about the economic importance of which it is obvious that for some time no final conclusion can be come to.†

* Vol. xliv., No. 2276, 1896.

† The British South Africa Company, by their original Charter, acquired rights over all the territory between the Molopo River (the northern boundary of British Bechuanaland), on the south, to the Zambesi River on the north. Subsequently the rights were extended up to the Congo State. The country, however, beyond the Molopo River and Zambesi, lying to the west of the Shashi and Ramaquaban rivers and the Pandamatenka road, is now under the direct contro

In the matter of communications with the rest of the world great progress has been made in the last three years. To reach Matabeleland in 1895 a costly and fatiguing journey of several days' duration from Mafeking or Pretoria had to be undergone. To-day through trains from Cape Town convey passengers and goods at a reasonable cost into the heart of Matabeleland. Buluwayo is brought within 3½ days of Cape Town and 20 days of England.

The railway, besides being an enormous benefit to the commercial development of the country, adds very much to the safety of the inhabitants, as assistance can now be brought in rapidly, should any further disturbances with the natives take place, and, moreover, it is a valuable security against famine. This is a point in favour of the extension of railways in undeveloped countries which must always carry considerable weight. In India we know that railway communication and cheap transport have now made the occurrence of a famine on the scale of former years impossible. In discussing the advantages to China of railways, Mr. Colquhoun says: "It is mainly the difficulty encountered by the Government in transporting the food supply that leads to the terrible loss of life." In South Africa the importance of it received a practical illustration in 1896 when owing to the rinderpest the ordinary means of transport failed, and food which was plentiful in some districts, rose to famine prices in others.

The present terminus of the Cape line is Buluwayo, but it is not likely to be so long. The survey to Gwelo (110 miles) has already been made and the line may be expected to be built in 1899. From Gwelo to the shores of Lake Tanganyika, a distance of 800 miles, the route is still uncertain, but an expedition was sent north last autumn to make a preliminary survey. The line will probably pass through the Mavain and Sinanombi or Sebakwe gold belts, and tap the extensive coalfield that lies away north towards Mafunga-busi, crossi the Zambesi River where it narrows at t Kariba Gorge or at a point lower down t river and nearer to the Portuguese boundary

When the railway reaches the southe shore of Lake Tanganyika, it will have arriv at the northern boundary of Rhodesia. Fr this point there are 400 miles of waterway the northern end of the Lake which will within comparatively easy reach of Ugan and its railway communications with Mombas The distance from the northern shore of Ta ganyika to Khartoum is approximately 1,5 miles, of which a considerable portion will water-way.

Another line that has been proposed is fr Buluwayo to the Victoria Falls, a distance the crow flies of about 250 miles, which lir besides bringing into easy reach one of t wonders of the world, which electricians a already anxious to make use of, will assist t development of the northern coalfield Wankie and of the teak forests of the Gwa Valley.

A branch line from Buluwayo to the Gwan district, about 100 miles south-east of Bul wayo, is also being surveyed. In Mashonala a railway line connects Umtali with the coa and connection will soon be made wi Salisbury.

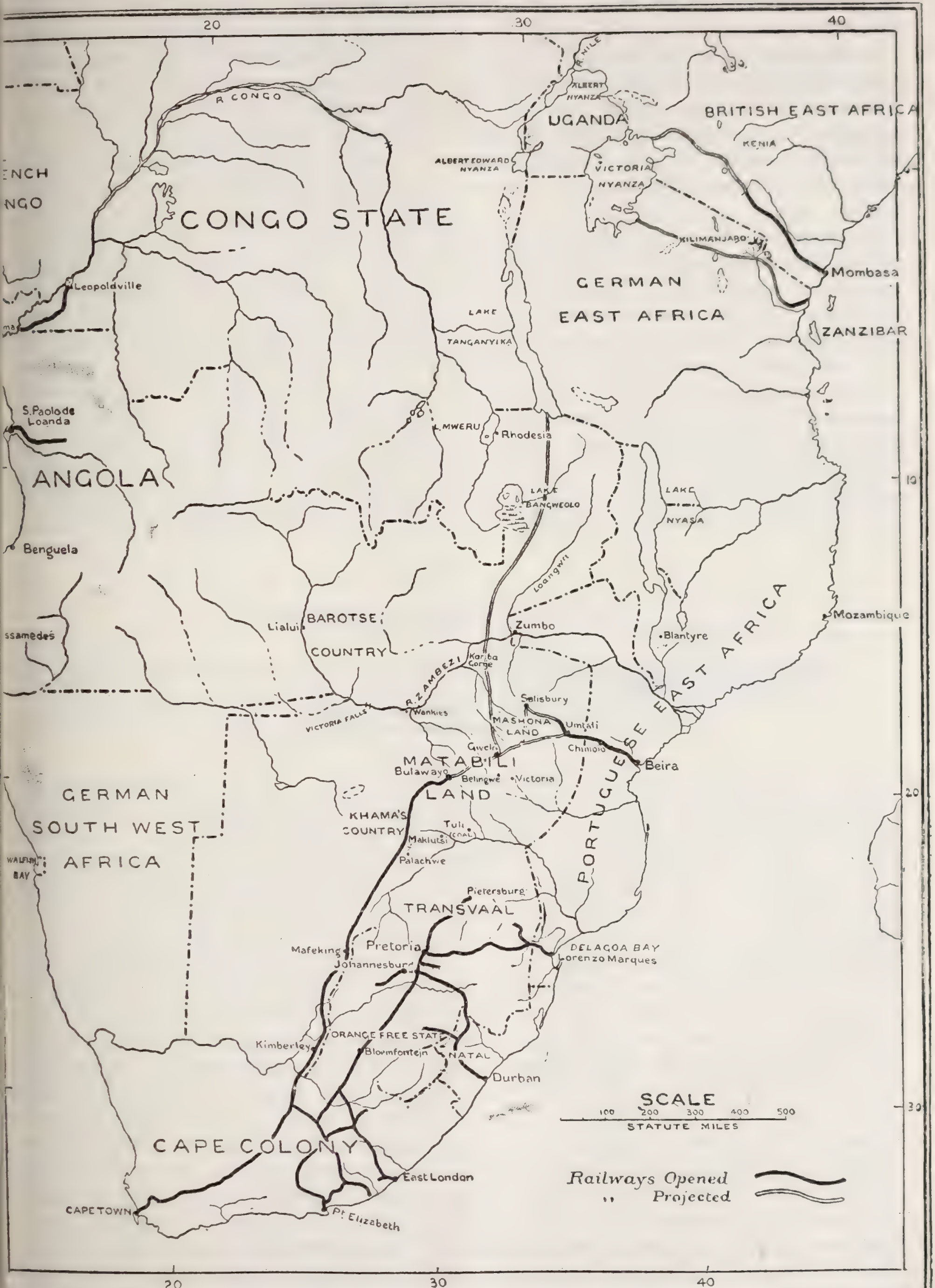
Although the railway has brought places li Buluwayo and Salisbury, places which n every globe-trotter visits, into touch wi civilisation, the interior of the country for t most part is still primitive Africa, where t traveller can enjoy undisturbed the freedom the veldt, off which big game has not yet be entirely destroyed. Many travellers ha written of the peculiar charm of wagg travelling in South Africa, and in the d season few countries can rival Rhodesia. T gipsy life, the variety of the sport, the pleasu of coming to rivers and mountains which ha as yet no place in the map, and above all t certainty of fine weather, all combine to ma life spent in this way pass only too quickly.

The different mining camps are connect by very fair natural roads, made by t waggons passing to and fro, the principal which are the main coach road between Bul wayo, Gwelo and Salisbury, which serves t mining districts of the Gwelo district, and t Tuli road, formerly the coach route to t Transvaal, but now only used as far Gwanda. There is also a fair road to Belingw The road from the Transvaal to Mashonalan viâ Tuli and Victoria, is now very little us

of the High Commissioner of South Africa, and called the Bechuanaland Protectorate. The boundaries of Southern Rhodesia are defined in Section 4 of the Southern Rhodesia Order in Council, 1898. Using Bartholomew's latest map (1898), and putting the Bechuanaland Protectorate back to the Pandamatenka road, the areas work out as follows:—

	sq. miles.
Northern Rhodesia, or British Central Africa, administered by the British South Africa Company	244,000
British Central Africa Protectorate, administered by the Foreign Office	38,000
Southern Rhodesia, administered by the British South Africa Company	156,000
Bechuanaland Protectorate, administered by the High Commissioner of South Africa	232,000

ce the advent of the railway, and the same y be said of the Mafeking Tati Buluwayo d.



Map of Southern Africa.

In Matabeleland the part of the country ere the roads seemed to me most requiring attention was between Selukwe and Belingwe, and Belingwe and Gwanda, so as to enable a traveller to make a circular tour and visit all the most important mining districts. The road between Selukwe and Belingwe is difficult, I

believe, at all times, and especially in the rainy season. A road between Belingwe and M'patene would also be a great convenience for travellers visiting the Gwanda district from the east.

In an appendix to this paper will be found some Tables showing the approximate distances between trading stores and water, which may be useful to travellers. I have also tabulated my observations for latitude altitudes by boiling point thermometer and the variation of the needle.

The minerals that have been discovered in workable quantities are coal and gold, of which the latter has naturally so far attracted most attention. There is good reason, however, to believe that, as a source of wealth in the future, coal may rival in importance the precious metal. The principal coalfield is along the Zambesi Valley, and coal has been found at a place called Wankie and at Sengwe. In the Gwaai Valley I was credibly informed that the most southern outcrop of coal formation occurs at the junction of the Gwaai and Bubi rivers, and a line drawn from that point to the known outcrop on the Sengwe River, and parallel to the Zambesi River, would roughly define the southern limit of Rhodesia's great coalfield. There is another coal area, which I have myself visited, near the Transvaal border and about 50 miles east of Tuli, but I think it is of minor importance to the Zambesi coal. At Tuli the coal can be seen outcropping in the bed of the Umzingwani River, and some prospecting shafts put down to the east of the river have picked up the seam, which I was informed is 9 ft. 6 in. thick, of which 4 ft. 6 in. is fair steam coal. The unfavourable feature is the large occurrence of trappean or igneous rocks in this district, and it seems probable that the seam or seams will be found to be much broken and disturbed. The coal formation consists of shales and sandstones, which are very flat and lie probably unconformably on a much older formation composed of garnetiferous micaceous schists, which are well exposed in the bed of the river. (Fig. 1.)

I was informed of the interesting fact that the same sequence of rocks occurs at the c[oal] outcrop in the Mafunga-busi district north [o]f Gwelo.

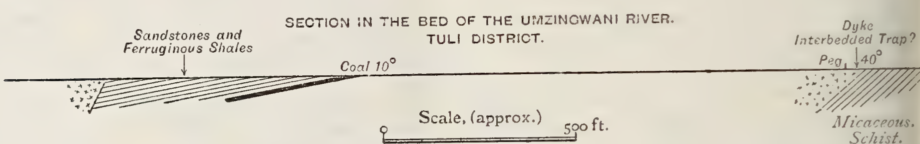
The future of the Tuli coal area depe[nds] largely on the success that awaits the g[old] mines of the Gwanda district, which are dist[ant] about 75 miles, and would naturally draw th[eir] fuel supplies from here when the timber rou[nd] the mines becomes scarce.

Before describing the work that is be[ing] carried on in the different gold mining distri[cts], it is advisable to make some general rema[rks] on the geology and physical features of [the] country. Matabeleland is bounded north [and] south by two great rivers, the Zambesi and [the] Limpopo, and the backbone, or watersh[ed], runs, approximately, half way between the [two] rivers. The high ground is composed [of] granite and constitutes the healthy portion [of] the country, attaining an altitude of 5,000 [ft.] above sea level. The land slopes gradu[ally] towards the rivers, the altitude on the Limpo[po] at Tuli being about 2,000 feet, and on [the] Zambesi, on the meridian of Buluwayo, al[tit]ude 3,000 feet. The granite itself, as far as I [am] aware, does not contain any mineral depo[sits] of economic importance. The aurife[rous] quartz veins or "reefs" are found in rock[s of] a different character, namely, metamor[phic] schists and slates, which occur over a [wide] area in certain well-defined belts.

There is considerable uncertainty as to [the] origin of the metamorphic rocks, it b[eing] doubtful whether they were originally s[edi]mentary rocks or igneous rocks made schis[tose] by dynamic metamorphism. It seemed to [me] that both classes of rocks were represen[ted]; at all events, I have seen slates that had e[very] appearance of being of sedimentary ori[gin], and in close relation to them schists that [are] evidently altered igneous rocks, a change [which] can be noticed even in small hand specim[ens].

In order to further investigate this sub[ject] I have had sections cut from severa[l] of the specimens of the rocks that enc[lose] the mineral veins, so that they might [be] examined under the microscope. The sl[ides] show that the dominant country rock i[s]

FIG. 1.



abase, and bring out clearly how a hard mpact igneous rock may be altered into a ft schist by dynamic action. There are also any places in the country where unmistakble dykes are seen traversing the schists. ood examples are to be seen in the Criterion id Bonsor mines.*

A further point of interest in connection with e origin of the metamorphic rocks is that at eir contact with the granite, the latter bemes schistose in character and altered into gneiss, indicating some dynamic change. A ction (Fig. 2), taken in the Insiza district, ill illustrate this point.

Although their origin is doubtful, the belts metamorphic rocks, which locally go by the mple name of "formation," are the home of e gold reefs. The average prospector will t think of looking for reefs in the granite, id I know one man, who on finding some iriferous quartz associated with granite, ingnantly said it was an insult to geology.

Prospecting in Matabeleland has been made isy for the present inhabitants owing to the ct that the country has been carefully plored by an earlier race, whose old workings e to be found in every direction on the schist rmation. Indeed, so thoroughly does the ork seem to have been done, that the chance a new discovery of importance being made small. I described the old workings at me length in my first paper, and I need only y now that they take the form of shallow enches or pits, filled up almost to the present vel and overgrown with bushes and trees, it still easily traceable. These old workings hich mark the outcrop of a reef, are seldom und to extend to a greater depth than 70 feet om surface, so that the modern miner can on recommence operations. It was at one ne thought that the shallowness of the old orkings signified a want of permanency in e reef, but modern developments have shown is view to be quite erroneous, and it is probable that the difficulties of mining below a certain depth alone accounts for the shallowness of the old mines. Thanks to the work of the ancient miners the country has been very rapidly prospected, no skilled miner being required to find the reefs. It is true there is an unfavourable side to the old workings, and that is that a portion of the reef has already been removed; still on the whole I think that the ancient miners have done more good than harm to the present inhabitants.

The new comers were not slow to discover that the old workings were the key to the gold reefs, and any place that showed a trace of the ancients was immediately pegged off, as well as a considerable length of ground called an "extension" on each end of the old working in the direction of the reef.

This wholesale pegging of old workings or of "extensions," accounts for the large number of claims and "miles" of reef that appear in the statistics of the Chartered Company.

With regard to the reefs themselves, the greater number are fissures in the schist formation parallel to the strike, and, therefore, interbedded. These fissures have been filled with quartz, and other minerals deposited from solutions. In width they vary very considerably, both in vertical or horizontal direction, being what are known as lenticular deposits. Fig. 3 will illustrate the shape they take in plan and section. The thicker portions of the reef, where payable, are traceable by the presence of old workings, and the longer their line is, the greater the strength and permanency of the reef below. The truth of this statement is confirmed by the fact that the most promising mines to-day have all a

Fig. 2.

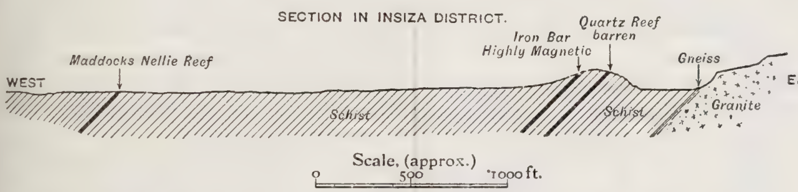


Fig. 3.

* Those interested in this subject should not fail to read a luable paper by Messrs. Chambers and Hatch, published in e "Geological Magazine," May, 1895.

long line of old workings marking their outcrop. If the converse of this is true, namely, that small old workings only exist on small reefs, which I believe to be the case, then with the knowledge we have of the value of the largest reefs (and practical results are happily forthcoming) we can draw conclusions as to what importance the mining industry is likely to attain. I may remark here that in mining a reef that has a well-defined outcrop, a contraction in strike or dip need not cause any alarm, as the probabilities are that the reef will again widen within a short distance; on the other hand, where only one or two small old workings occur at surface, it is probable that, outside the limits of the old workings, no reef of any size will be met with. While I have confidence that the stronger reefs will continue in depth to a sufficient distance to allow of profitable mining to be carried on, I think that the smaller reefs will prove disappointing owing to the small quantity of quartz available for mining. So far I have endeavoured to show that the old workings are extremely valuable as a guide to the position and importance of the gold reefs, and that, as they are so easily found, much of the uncertainty as to the mineral wealth that exists in a new country is thereby removed.

After these general remarks, I shall now pass on to describe the mining work that was being carried on in Matabeleland in 1898. Of Mashonaland I have had no experience, but I may say that the geological and economic conditions there are similar to those existing in Matabeleland. More progress, however, seems to have been made in the western than the eastern province, where the mining districts, except as regards Umtali, are less accessible.*

I do not pretend, of course, to have compiled an exhaustive list of the mines working, but I have endeavoured to include all the best known properties and those that I know to be, whether ultimately successful or not, at all events genuine mining ventures, so that a fair idea may be formed of the scale upon which mining is being carried on. I have purposely omitted any figures to show the value of the reefs, except in the case of the producing mi[...], since assay results without a good deal [of] explanation as regards quantities of ore, [are] sure to be misleading. When I tell you t[hat] even in the hands of an experienced engin[eer], the correct valuation of a well-developed qu[artz] mine, in which a large number of samples [ha]s to be taken is a lengthy and laborious proc[ess], you will understand how dangerous are pre[dic]tions as to the future of a mine when based [on] data derived from an insignificant amount [of] development work.

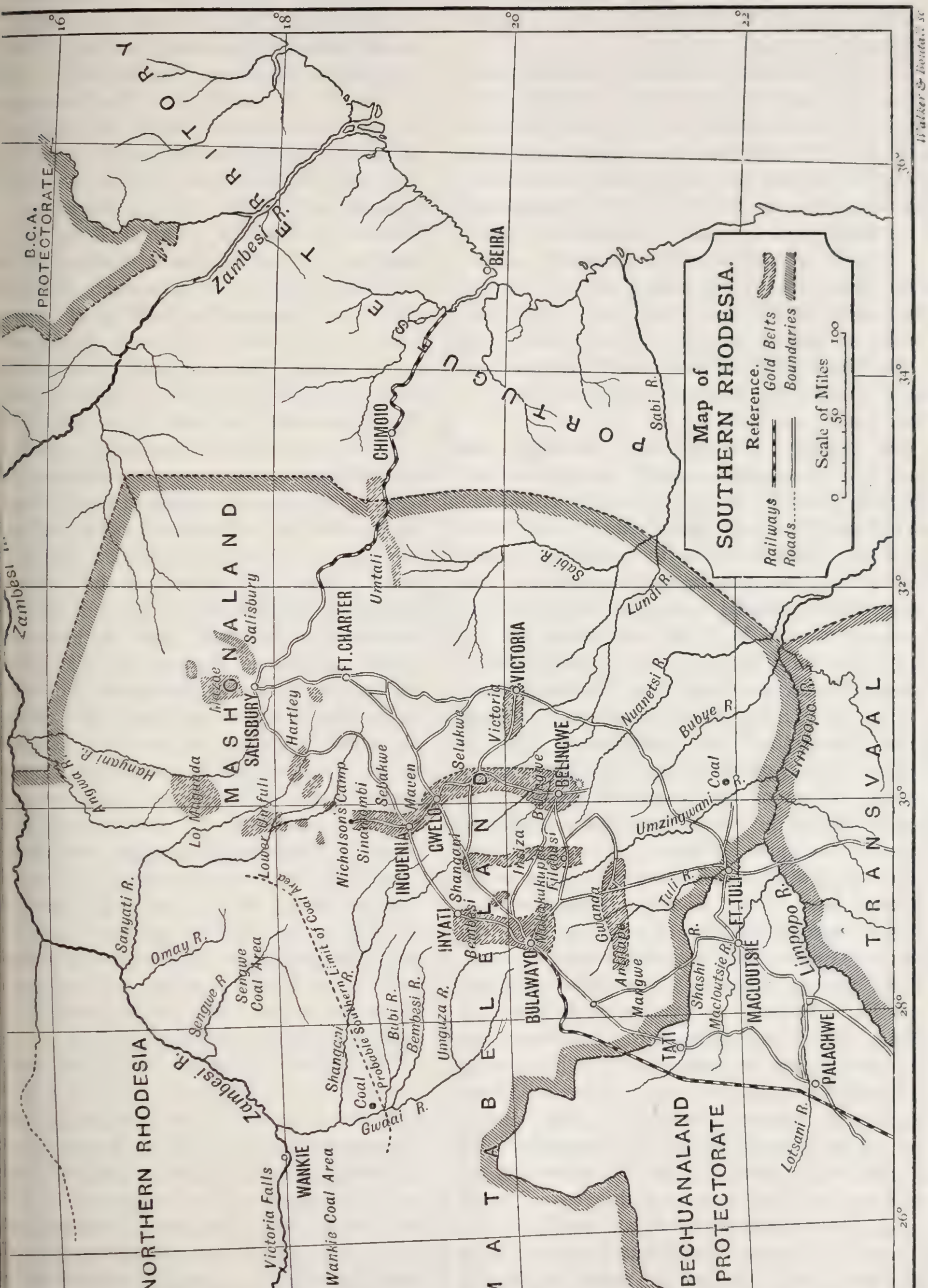
I mentioned above that the geological [for]mation forms a reliable guide as to the situat[ion] of the reefs, the metamorphic rocks be[ing] favourable and the granite unfavourable. [The] different mining districts are the belts of m[eta]morphic rocks which are fairly evenly [dis]tributed along a line joining Tati and Salisb[ury]. Although distinctive names are given to th[e] belts, it does not follow that they are disti[nct] in themselves, and when a geological surve[y is] made, it seems to me probable that some of [the] belts now marked separate will be found to [be] connected. In Mashonaland the most promin[ent] mining districts are those of Umtali, Salisb[ury], Mazoe, Hartley, and Lo Magonda. In Ma[ta]beleland the most advanced districts are [the] Selukwe, which lies about 25 miles south [of] Gwelo, and the Gwanda which is about [.] miles south-east of Buluwayo. In the B[ulu]wayo district, several reefs are being work[ed], some in the immediate neighbourhood of [the] town. The mine on which most work has b[een] done is the Criterion, which lies about ei[ght] miles south of Buluwayo, and which, [on] account of its accessibility, is one of the s[how] mines of the country. The management m[ost] courteously give every facility to visitors [to] make a thorough inspection, an exam[ple] which I may say in passing is followed [by] almost every other mine in Matabeleland.

The system adopted of proving the prop[erty] is that of sinking in the old workings [and] driving a level along the strike of the [reef] below the lowest point reached by the ancie[nts], a depth which is usually 70 feet. In this [wa]y reliable data is obtained as to the length [and] value of the pay chutes, from which the s[cale] upon which the mine should eventually [be] worked can be calculated. Eight shafts h[ave] been put down, the deepest being 250 f[eet], and several hundred feet (about 1,600) [of] driving have been done on the first level [of] 150 feet.

A fine reservoir to hold 30,000,000 gall[ons] has been made at a cost of £6,000, so as [to]

* I must draw attention to an interesting paper recently published "on the Future of Goldmining in Mashonaland," by Mr. C. T. Roberts, President of the Salisbury Chamber of Mines. Although I am in sympathy with a great deal that Mr. Roberts says, I disapprove of his method of estimating the length of reef available for mining. Very false conclusions must, I think, be come to when the length of ground pegged is mixed up with the length of payable reef; further I do not think any comparison between the banket beds of the Transvaal and the quartz reefs of Rhodesia is permissible.

vent any stoppage during the dry season. :o-stamp battery is in course of erection to roughly test the value of the mine. At the



: of my visit the mine was employing 16 es and 200 natives. The mine is perhaps best situated in all Matabeleland for economical work, and has the great advantage of being in a very healthy district.

Leaving Buluwayo by the northern road, a drive of about 25 miles brings one to the Bembesi district, which has been extensively pegged upon; but when I visited it in the early

part of 1898 the Queen Mine was the only property being worked. It is only fair to say that I went at the most unhealthy time of the year, and later on I heard of work being done on other properties, especially on the Umguza river, with promising results.

The Queen Mine has some good old workings, and has been worked on and off since 1895. The mine makes a good deal of water, and the development work has been slow probably on that account. There were about six white men on the mine, and preparations were being made to erect a rock-drilling plant, so that it is evidently the intention of the management to push ahead with the work. The main shaft, which can boast of an iron headgear and a winding engine and pump worked by steam, is down about 100 feet, and there was about 150 feet of driving done at that depth.

On leaving the Bembesi district, and travelling in a north-easterly direction along the old Hunter's Road to Hartley Hills, the traveller will reach the goldfields that lie to the north of Gwelo, called the Mavain, Lower Gwelo, Sebakwe, and Sinanombi districts. The old Hunter's Road is now but little used on account of the bad drifts or fords at the Shangani and Umvungu rivers, and the traffic between Buluwayo, Gwelo, and Salisbury takes a road some miles to the south that follows more closely the line of watershed. The old Hunter's Road passes through the picturesque granite kopjes of Taba-y-momba, used as a stronghold by the natives during the rebellion, and the Somabula Forest, a thick belt of trees which from their size deserve rather the name of wood than forest. Except during the rainy season anyone visiting the mining districts north of Gwelo should certainly take this route. There are no wayside stores between Inyati and Fort Ingwenia, a distance of about 76 miles. There used to be a store between these two places, but the owner lost his life during the rebellion, and it was not reopened. As an illustration of the way in which an Englishman can adapt himself to circumstances in an out of the way place, I may be permitted to mention that the owner of this store had a passion for cricket, which of all games is least suitable for anyone condemned to a solitary life, and I was told that he never lost heart, but always did his best to play a match with any traveller who happened to pass along that lonely road. The love of outdoor games has always had a healthy influence on English character, and there is no doubt that we owe much of our success in colonizing to the qualities which games inspire. It was characteristic of our country that when Capt. Lawley, the Administrator of Matabeleland, went only a few months back on a diplomatic mission to the Zambesi to meet King Lewanika of Northern Rhodesia, the conference should be wound up by a display of athletic sports, which of all the ceremonies that took place during the visit was probably the most impressive, and the one that will be the longest remembered. In the Mavain, Ingwenia, and Sinanombi districts a good deal of prospecting and development work has been done, but it seems to have been undertaken more for the purpose of fulfilling the requirements of the Mines Ordinance, which insists on an annual footage being done, than for seriously testing the value of the properties. My experience is that the reefs though often of good value are small, and that the problem will be to work small quantities of high grade ore, rather than a large tonnage. These reefs do not appear to be sufficiently encouraging to warrant further expenditure under present circumstances, but when the railway is extended to Gwelo, and possibly to Sinanombi or Sebakwe, some of them may be made to pay. At present the difficulties of supervision, the unhealthiness of the climate, the scarcity of water, and the cost of transport all militate against exploratory work except on the most promising properties. Doubtful properties are in most cases being left alone, until the results of the best properties are known. These remarks apply not alone to these districts but generally to the whole of Matabeleland. Of the Sebakwe district I am not able to speak from personal knowledge, and I am glad to say that I have very favourable reports of its prospects. Among the best known properties are the Globe and Phœnix, and the Gaikwa and Chicago mines.

The Selukwe district, which lies south of Gwelo, a small township to which the success of the mines is of vital importance, is perhaps the most advanced of all the mining districts of Matabeleland. The most important mines are the Camperdown, the Dunraven, the Bonsor and the Selukwe (formerly Tebekwe) mines. The three latter have already reached the producing stage. From a geological point of view, the Tebekwe reef is the most regular of all the reefs that I have seen in Matabeleland, being a nicely-banded six foot quartz reef with well-defined walls. The old workings are traceable about 3,200 feet in length. Shafts

ve been sunk at intervals along the outcrop l the 100 foot level has located the pay ites. The main shaft was down 200 feet, l a second level was being driven. The mecting winzes from the first level have ved the continuation of the reef to the ond level, where it maintains its strong iracter.

'he Bonsor Mine also possesses a strong f, and the lowest workings, some 300 feet ow the outcrop on the hillside, looked very ilthy. I have pleasure in mentioning this, the mine was one of the first to offer an mple proving that the reef continues below workings of the ancients, in short, that the fs are, at all events in some cases, of a manent nature. The development of the ukwe mines has been facilitated on account he hilly character of the country, which has bled the reefs to be opened out by adits or leries driven into the hillside.

'he Camperdown reef is of an exceptional racter, being apparently not interbedded the majority of the reefs in Matabeleland, cutting across the formation which is gely composed of iron shades. The reef mall on the first level, averaging perhaps lve inches, and contains a remarkable ount of visible gold which makes the correct npling of the mine a matter of difficulty ng to the great variation in the assay ilts. A mine of this description requires be developed on a large scale to enable able estimates to be made of its capabili- .

'he Selukwe district has a fair timber and er supply, and offers every facility for econo- al mining. The higher parts, where the es above-mentioned are situated, has an tude of between 4,000 and 5,000 feet, and sequently ought to be healthy. During last wet season, however, there was a e amount of malarial fever, but bad living the turning over of new ground may have a good deal to with this.

n the same chain of mountains as Selukwe about 75 miles south, is the mining dis- of Belingwe. The mountains terminate ewhat abruptly in a prominent landmark ed Belingwe Peak, which lies seventeen s almost due south of the Central Camp, re the police camp, the native Commis- er's quarters, and the general store that es the district are situated. It is here the advantages of centralisation as regards agement are well illustrated. A large ber of the mining claims belong to one Company, which, unlike other companies with interests, scattered about the country, can afford to keep a capable staff at a central establishment, provided with a laboratory, smith's shop and a trial crushing plant, within easy reach of the mines, thus enabling the development work to be carried on in the most economical manner. By amalgamation of interests this system of management might advantageously be followed in other districts. The road to the Peak, which passes an interesting outcrop of serpentine, containing small veins of asbestos, is alive with claim beacons, but the Wanderer's Rest Mine was the only one on which work was being done. The reef is about 2 ft. 6 in. wide, interbedded in hard slate, and dips south at an angle of 35°. The main shaft is down 130 feet on the incline.

The Dobie Mine is situated close to the Central Camp. The Ancients have attacked the reef, which outcrops on a hillside, by an adit, and have worked out a good slice of the hill. Where they left off the quartz was poor, but recent development work has struck some remarkably rich ore, composed of honey-combed quartz, below the old workings. It is a good example of the erratic character of quartz-mining, one day rich and another poor, and shows how necessary it is, in order to prevent disaster, to have the development of the mine well ahead of the mill.

At the Confidence Mine, which is situated about two miles north of Belingwe camp, there is a nice run of old workings, extending about 400 yards. The mine is well equipped with portable machinery, and is a model of what a prospector's camp, far removed from supplies and workshops, should be. Among other properties that were being developed in this district, but which I did not visit, may be mentioned the Zalandia, Fondoque, Sabi, and Mount Wedza claims.

So far the indications go to show that Belingwe has several reefs containing chutes of high grade quartz which with small batteries ought to make in the future no unimportant contribution to the gold output of Rhodesia.

About halfway between Belingwe and Bulu-wayo is the Insiza gold belt which runs approximately north and south, and upon which several reefs are being developed. Judging from what I saw the reefs are small and good examples of the lenticular character of the quartz reefs in this country. At the southern end of the belt, the Ancients Mine was the only one being worked. Other belts within no great distance of the Insiza district,

with which some may be geologically connected, are the Shangani, with the Eagle mine, the Umzingwani, Balla Balla, Makukukupen and Filibusi districts.

Further south again, and some 75 miles south of Buluwayo, is the important district called Gwanda. It contains some very promising properties, including the Geelong Mine, which was the first mine in Matabeleland to declare an output. The belt, which is comparatively narrow being only about 12 miles across, runs for about 50 miles east and west, commencing on the east at the Umzingwani river, where are situated the Geelong and the West Nicholson reefs.

The Geelong reef outcrops on a kopje upon which are the mine workings. The reef is a wide body of quartz, being as much as 20 feet wide in some places. The strike is east and west and the dip north at about 30°. The underlying rock looks like a granite which has been altered into gneiss for about 18 inches from the reef. The specimens, which I brought home, when examined under the microscope, showed that the rock on the footwall was a fine white mica schist, resting on gneiss. On the hanging wall of the reef comes the ordinary schist with a thickness of about 50 feet, and then there is another quartz reef, but not so wide as the first. Beyond this I do not know what the formation is, but the granite cannot be very far off, and the mine seems to be situated very near the eastern end of the Gwanda gold belt. Some of the old workings, which are extensive, have been cleared out and the mine restored to its condition as left by the Ancients. The blackened walls, proving that mining was carried on by fire, and the round diorite stone hammers which are found in many places about the mine, are evidence of the primitive methods employed. The main shaft, which is a three-compartment shaft, timbered with mopani, the local ant-resisting wood, is down to about 300 feet, opening up the reef for two levels. A 20-stamp mill (1,050 lbs.) has been erected, and crushing was commenced in the month of October, 1898, but no cyanide plant is yet in operation. It is intended to double the stamping power as soon as possible. At the time of my visit 53 white men, many temporarily engaged on construction work, and 300 natives were being employed. The Geelong camp has been laid out with great care, and the *employés* made as comfortable as possible. A plentiful water supply has been brought in from the Umzingwani river, distant three miles. Good wood and iron bu[ild]ings have been erected and lighted by elec[tric] light. One of the most noticeable things at Geelong was the kitchen garden, for fresh ve[ge]tables in Matabeleland are, as a rule, outside towns, unprocurable. A clearance had b[een] made in the bush and the land irrigated by water pumped up from the river. The gar[den] was in charge of a coolie gardener, and I [was] informed that all the ordinary vegetables g[row] well. There is a great need for fresh veg[e]tables here as the place is very unhealthy[;] [I] was told that last season not a man esca[ped] malarial fever, and that there were two dea[ths]. The natives, too, also suffered severely. A[bout] seven miles from the Geelong is the W[est] Nicholson Mine, which is being actively [de]veloped, employing six white men. It is [said] to have the same characteristics as the G[ee]long, but is a wider body of quartz. [The] district is well supplied with timber, but [it is] mostly small. There are, however, some l[arge] mahogany trees, and I saw a log going thro[ugh] the saw-mill that measured 27 by 19 inche[s].

Another promising reef in the Gwa[nda] district, upon which development work [is] being carried on, is the Eaglehawk or Vul[ture], which is situated about halfway between [the] Geelong and Manzimnyama. A 5-stamp ba[ttery] has been erected for testing purposes. [The] reef is in schist formation, and the old work[ings] extend for at least 1,500 feet, auguring wel[l for] the strength of the pay chutes. The main [shaft], fitted with iron headgear, engine and b[oiler], was down about 150 feet. I was informed [that] development work was also being carrie[d on] in a greater or less degree on the Ismain, [Aus]tralian, Cameel, and Jackal reefs. The Ant[elope] Mine was being vigorously prospected, em[ploy]ing 15 white men. The reef, which is comp[osed] of blue quartz, was 2 feet wide, at a depth o[f ...] feet. The old workings extend for 400 [feet]. A 10-stamp battery is to be erected. Mo[st of] the Gwanda properties lie to the east o[f the] main Buluwayo Tuli road, but there are [...] claims to the west, amongst others [the] Umchabesi, Tuli River, and Lady reefs, [on] which a little work was being done.

The Gwanda district promises to be o[ne of] the most important in Matabeleland. [It is] unfortunately unhealthy and badly off for w[ater]. It is proposed to connect it with Buluwayo [by a] railway that will follow the Umzingwani v[alley], and when that is built, many of the diffic[ulties] that now retard progress will be removed.

From the above description of the work [that] was being done in Matabeleland during [...]

ill be seen that the list of mines producing earing the production stage is not a long ; still it is sufficient to show that the min- industry is one that will flourish on a lerate scale. The number of stamps shing at the end of 1898 was 100, exclusive small trial batteries, and I understand that ut 200 more are on order, exclusive of any t may be wanted for Mashonaland. As ards the number of persons engaged in ing, it was stated at the last general meet- of the Chamber of Mines at Buluwayo, t 2,000 whites and 10,000 natives were ployed in mining pursuits in Rhodesia. ese figures do not agree with the census t I took, but the difference may be partly ounted for in that the figures mentioned ve include officials in the towns while mine not. For an individual to take a census may ear difficult, but, as a matter of fact, it is y, since in each mining district it is sure to known at the trading stores what work is ng on. I made the number of whites on mines of Matabeleland to be under 400, l of natives under 4,000. The Mashona- d total must be less than this, so that the nd total for Rhodesia would be considerably s than that quoted above. The gold pro- ction so far from the four mines crushing Matabeleland has been on the whole satis- tory, and proves the payable nature of the fs.

Below I give the figures, which are for the ld won by amalgamation from the mill, and clusive of the gold in the tailings, which uire a cyanide plant for treatment.

cluded in these figures, which nevertheless compare favourably with those of the Rand, where the costs for 22 outcrop mines in 1897 were 27s. 7d. White labour is about the same in both places, but explosives and native labour are less in Rhodesia. Anxiety has been felt that a sufficient supply of native labour would not be obtainable, but no serious trouble has yet been caused in Rhodesia on this account.

The figures given above show that the costs of working will not be an obstacle to the successful development of the mines. Judging from the results so far obtained, it seems likely that in each district there will be one or more successful mines. A gradual expansion is, of course, to be expected, but it must not be forgotten that it is the pick of the mines that are now been opened, and that the same promising results must not be awaited from those properties that follow after.

Although it is about the mines that I particularly wished to speak, I would not have you believe that it is on their success that the future of Rhodesia entirely depends. I think it is a mistake to hold this view. In my opinion the future of the country is bound up with its pastoral and agricultural possibilities.

Farming is certainly not yet carried on to any great extent, but poverty of the soil is not the reason. The mealie fields of the natives, which are to be met with all over the country, and the market gardens round Buluwayo and other townships demonstrate that the soil is capable of successful cultivation, and it is well known that before the rinderpest came, the

TABLE A.

Mine.	No. of Months' Crushing in 1898.	No. of Stamps.	Tons crushed.	Bullion ozs. recovered from Mill.	Bullion dwts. per ton.	Estimated value calculating at 70s. per oz.		Tailings Assay dwts.
						Gross. £	Per ton. s.	
eelong	4	20	8,890	4,639	10·4	16,236	36·40	6·0
elukwe	3½	20	6,133	4,208	13·7	14,728	48·02	5·7
unraven	3¼	20	6,376	3,834	12·0	13,419	42·08	2·5
onsor	2	40	6,900	3,495	10·1	12,232	35·42	3·5
Totals....	—	100	28,299	16,176	11·4	56,615	40·00	—

The official working costs at the mines vary m 27s. to 18s. 3d. per ton, exclusive pre- mably of expenses at headquarters and of preciation, the average probably being out 24s. per ton milled, which is very asonable considering the situation of the ines and the small size of the batteries. yanide costs, as above stated, are not in-

country supported a large number of cattle. The high veldt in particular, with an elevation of 4,000 feet, is suitable for farming.*

It is to other causes, preventible, I think, in

* The area available for farming above 4,000 feet is estimated by Mr. Selous at 26,500 square miles, and above 3,000 feet at 99,000 square miles.—British Association, Toronto Meeting, 1897.

most cases, such as malaria, drought, cattle disease, locusts, and absence of markets that the backwardness of farming is due.

The greatest curse of the country, as it is of all tropical Africa, is malaria. "Malarial fever," says a distinguished writer, "is the one sad certainty which every African traveller must face." In travelling about the country at the close of the wet season of 1898, admitted on all sides to have been the worst on record, I saw what a paralysing effect this disease had on the progress of the country. Buluwayo is practically free from malaria, and it is encouraging to note that places which are occupied have a tendency to become more healthy, but in the outside districts, among the prospectors, the traders, and the police, malaria was only too common, and had many victims.

Whether malaria is preventible is a question that has received much attention, and last month a striking paper, by Dr. L. Westenra Sambon, was read before the Royal Geographical Society, and was followed by an interesting discussion in which many prominent African travellers took part. Although the meeting was unanimous that malaria was the most important obstacle to the colonisation of tropical Africa, those present were not all so sanguine as the author that medical science would before long find a means of destroying the power of this crushing disease. Still, it is encouraging that some, at all events, should believe that it can and will be done. May I be allowed to quote from Dr. Patrick Manson's remarks, words which cannot fail to be welcomed by many in Africa :—

"There are, however, signs that the day of deliverance from this worst curse of mankind is at hand. Fact after fact is coming to light about the malarial germ, and step by step we are approaching that complete knowledge of its life history which alone will enable us to crush out this terrible parasite, or at all events to protect ourselves from its attacks."

So much has already been done in preventing the spread of disease in the animal kingdom, that I feel confident that some practical means of overcoming malaria will be found. The discovery will be of far-reaching importance and will accelerate the opening up of Africa.

Turning now to some of the other disadvantages that the farmer has to contend against in Rhodesia, I may refer to drought. Nearly all the rainfall comes within two months, the rest of the year being practically dry, and the consequence is that during the wet season the rivers are flooded and during the dry they are little else than rivers of sand. During the winter months water is found pools in the river beds, but is on the wh very scarce. It is obvious that in a coun like this the storage of water for irrigati purposes is required, necessitating a co siderable capital outlay.

Besides malaria and a scarcity of water t farmer has other troubles to contend wi Rinderpest and lung sickness decimate cattle, locusts more than decimate his cro his young trees and plants are eaten by wh ants, even his poultry have a special complai Fortunately science is coming to his resc and many of the plagues that formerly m have driven the farmer to despair are n mitigated, if not entirely conquered, by t inoculation system.

The British South Africa Company ha taken the greatest pains to stamp out rind pest. Inoculation stations have been plac on the main roads, and no cattle are allow to pass that have not the Government bra I spent some time at one of these stations, a learnt a good deal about inoculation. T system at first adopted was to inoculate w serum or the blood of a "salted" ox (*i.e.*, ox that has recovered from rinderpest) on o side simultaneously with the blood of a rind pest sheep on the other; the animals we then put in quarantine for ten days. I sorry that I have no statistics to show wh per-centage of animals survived this treatme but I was informed that very few animals w lost. The inoculation with rinderpest blo has now been done away with and only t serum is injected, and no quarantine impos It may be of interest to state that rinderp can only be transmitted through three she as in the third remove it becomes too virule The cattle belonging to the natives are compulsorily inoculated, as this might lead trouble, for if there is one thing that a nat objects to it is any interference with his catt

Among the reasons why farming does flourish, I have put down absence of marke This is a difficulty that, I think, the impro ment in the means of communication will over. Distance from markets nowadays d not seem to be of much account. It is curi that at the present time Buluwayo should eating New Zealand mutton, and that it sho pay to bring up fresh fruit and vegetables fr Cape Colony. In a large country like Rhodes with an altitude ranging from 2,000 to 5,000 fe and with a soil which is admitted to be in ma parts most productive, there ought to be a wi range of products grown.

In bringing this imperfect sketch of the [re]sources of Rhodesia to a close, I should like [to] say one word as to the administration of [th]e Chartered Company, and in doing so I [ou]ght to add that I travelled about the country [ar]med with no letters of introduction to officials, [an]d that I have no pecuniary interest in the [co]untry whatever. The impression I obtained [wa]s that the settlers in Rhodesia have every [re]ason to be satisfied with the way in which the [ad]ministration of the country is being carried [o]n. It is only natural where there are so many [di]fficulties to contend against, where progress [is] slow and success only attained after many [di]sappointments, that some of the settlers [sh]ould complain that it is the administration [th]at is to blame. The accusation seemed to me [en]tirely unfair. For what are the facts? In a [co]untry which only six years ago was in the [h]ands of a savage people, you now find [in]stalled the machinery of a civilised Govern[m]ent; you find law and order administered by [a] judicial and civil service of high standing, a [n]ative department that is just and which [co]mmands respect; railway, postal, and tele[g]raphic communication with the outside world. [Y]ou find the Government making experiments [a]s to what products are suitable for the country, [t]aking every precaution to stamp out cattle [d]isease, subsidising the hospitals, and making [p]reparations for a trigonometrical survey. I [d]o not think the Chartered Company can be [a]ccused of shirking its responsibilities to the [s]ettlers; on the contrary, it seemed to me that [t]hey were offering them all the assistance in [t]heir power to bring the development of the [c]ountry's resources to a successful issue.

APPENDIX.

MATABELELAND, 1898.

Altitudes by Boiling Point Thermometer.

	Feet.
[B]uluwayo	4,450
[G]welo	4,650
[T]wo miles south of Fort Ingwenia	4,150
[S]inanombi (Nicholson's Camp	3,750
[B]elingwe Camp	3,360
[T]uli Coalfields	1,880
[S]elukwe Camp	4,800
[I]lmeni Drift, 9 miles north of Manzimnyama	3,400

Variation of the Compass.

[B]uluwayo	20°·50′ W.
[G]welo	17°·03′ W.
[B]elingwe	17°·18′ W.

Road.—Fort Rixon to the Shangani (Buluwayo-Gwelo Road.

	Miles.	
Fort Rixon	—	Schist, general bearing from Rixon's to Ancient ruins. N 62 E true—fair road.
Granite outcrop	$4\frac{1}{2}$	
Ancient ruins	4	Granite.
Kraal (schist)	$2\frac{1}{2}$	Bearing from ruins to main road true north—only wagon spoor this bit, but easy country.
Buluwayo-Gwelo road	$9\frac{1}{2}$	
Shangani Grove	2	
	$22\frac{1}{2}$	

TABLE OF DISTANCES.

Buluwayo-Belingwe Road (by cyclometer)—

	Miles from place to place.	Miles from Buluwayo.
Buluwayo	—	—
Umgusa River	6	6
Graham's Store	$5\frac{3}{4}$	$11\frac{3}{4}$
Bates' Store	$16\frac{3}{4}$	$28\frac{1}{2}$
M'yazanne River	$15\frac{3}{8}$	$43\frac{7}{8}$
Insiza River	8	$51\frac{7}{8}$
Crofts' Store	$6\frac{5}{8}$	$58\frac{1}{2}$
Finger Kop	8	$66\frac{1}{2}$
Stable	6	$72\frac{1}{2}$
Masha Busha Hills	11	$83\frac{1}{2}$
Posselts' Farm	$12\frac{1}{4}$	$95\frac{3}{4}$
Belingwe Camp	$11\frac{1}{2}$	$107\frac{1}{4}$

Buluwayo-Tuli Road—

Buluwayo	—	—
Travellers' Rest Store	14	14
Umzingwani River	10	24
Store (cross-roads to Insiza)	6	30
Umlugulu Fort	2	32
Matoppos Store	4	36
Grainger's Store	12	48
Ilmeni Drift	4	52
Saber's Store	8	60
Ilmeni Drift (2nd crossing)	6	66
Poort	3	69
Manzimnyama Fort and Store	6	75
Cross-roads to Geelong Mine (distant 22 miles)	3	78
Cross-road to Geelong	2	80
Joandas Store	6	86
Makalaka Kop (water)	5	91
River (water)	2	93
Old post-station	2	95
Pourri Perri Store (well)	9	104
Oliphant's Pits (water sometimes)	19	123
Old post-station (Rietfontein)	11	134
River (water)	10	144
Tuli River (Wegdrei)	12	156
Tuli Store and Fort	2	158

Tuli to Umzingwani Coalfield—

Tuli	—	—	Trap.
Steep Hill	4	4	No grass or water.
Cross-roads leave Victoria Road	2	6	Thick bush.
M'Kate's Kraal	1	7	
River	7	14	Trap rocks.
Ipagi River	1	15	
Mologa River	1	16	
Marabe River	1	17	
Outspan	8	25	Lat. 21°. 56′. 39″ S.
Kraal (water)	5	30	Scrub. Trap rocks. Large trees N. of road.
Koppies; water	7	37	Sandstone koppies with trap dykes at 37 miles; caves and deserted kraal.
Cross-roads	1	38	Keep right-hand road.
Umzingwani River	9	47	Thick bush and low sandstone koppies, with baboons.
Kopje with kraal, right bank of river	1	48	Lat. 22° S. Alt. 1,800 feet.
Coal outcrop and bank	2	50	

Latitude Observations.

	Degs.	Mins.	Secs. S.
Gwelo	19	27	40
Aztec Camp, two miles south of Fort Ingwenia	19	11	25
Sinanombi, Nicholson's Camp on Kopje, near Sinanombi river drift	18	43	57
Belingwe Road—			
Croft's Store, Insiza	20	13	57
Six miles east of Finger Kop	20	16	38
Six miles east of Masha Busha Poort	20	23	00
Six miles east of Posselt's Farm	20	24	35
Belingwe Central Camp	20	27	50
Fort Filibusi, on Tuli-Buluwayo Road	20	30	26
Pourri Perri Store	21	15	30
Salt River, the first water south after Pourri Perri	21	45	37
Ilmeni drift, 23 miles north of Manzimnyama and four miles south of Grainger's Store	20	37	41
Tuli to Umzingwani Coalfields. Road, 25 miles east of Tuli	21	56	39
Two miles north of outcrop in Umzingwani River	22	00	05

Belingwe to Manzimnyama.

ROUTE A.

Belingwe to Fort M'Patene 35 miles. There is road as far as the Peak 17 miles, but none beyon towards M'Patene.

M'Patene to Geelong (wagon road) 30 miles.

Geelong to Manzimnyama (coach road) 25 miles.

ROUTE B.

	Miles from place to place.	Miles from Belingwe.	
Posselt's Farm	12	12	Cross-roads, th right hand ro leads to Insi and Buluway
Nuanetsi River	16	28	Granite.
Shambo Mountains	2	30	
N'Congesi River	6	36	
Cross-roads	2	38	Road t M'Paten S.E.
Poort	3	41	Schist.
Insiza Fort and Edkins Store	4	45	
Insiza River	3	48	Schist treil S.E. & N.W (mag.) di N.E.
Umzingwani River	9	57	g. store or bank.
Balla Balla Fort	6	63	Cross-road Road t Buluwayo v Makukuku pen.
Store at Cross-roads Buluwayo-Tuli Road	12	75	
Umlugulu Fort	2	77	Granite.
Manzimnyama	43	120	Schist.

DISCUSSION.

The CHAIRMAN said Mr. Wilkinson had given very fair and impartial account of the prospects Rhodesia, neither exalting nor depressing its futu unduly, and it might be gathered that the futu would be a very bright one. They were indebt to the energy and foresight of one man for th large and valuable addition to the Empire, and t country was very properly named after him. Th could only hope that he would achieve such succe on his present visit to England as would secure t construction of the railway tapping the coal-field and so ensure a supply of fuel for the mines. Th would then be able to follow in the wake of t ancient workers to revive the memory of Solomo and obtain abundance of wealth from that territory.

Sir SIDNEY SHIPPARD, K.C.M.G., said visited Matabeleland in 1888, when Lobengu was at the zenith of his power, just befo

concession had been granted on which the rtered Company was ultimately founded, and difference between the resent state of country and what it was then was someg marvellous. The contrast and the growth the country in 10 years was enough to give onable ground for hoping that even apart from mineral wealth, Matabeleland would in time ome a highly prosperous and valuable addi- to the Empire. He did not know that he ld add anything to the paper, but he could rtily endorse what the Chairman had said as to importance and the work done by Mr. Rhodes.

ir Richard Temple, Bart., G.C.S.I., said he ly had no claim to say anything on this asion, never having been in South Africa, he was glad of the opportunity of express- to Mr. Wilkinson and their African friends sentiments entertained by that imperial party England to which he was sure every one present proud to belong. The author had made y things clear which were important and inter- ng to the future of the Empire. The paper not only valuable from an engineering and ing point of view, but was full of sound itical economy, and showed what the future of odesia was to be. There was a discriminating ount of the different mining districts, and he was l to learn that in some parts the supply of gold ned likely to be permanent. One could not help ching a kind of weird and romantic interest to antiquarian part of the subject, which showed t from the earliest times gold had been worked in district; but the chief point of interest was that shonaland and Matabeleland could be colonised ler peculiarly favourable conditions. In most our colonies the difficulty was with regard to our: where there were only white men labour was rce and expensive; and on the other hand, where n Northern Australia there were coloured races, climate was generally too hot for Europeans; but e, if he understood rightly, the climate was fairly d for Europeans, and yet there was good native our supply. There seemed to be a short rainfall, it was abundant, and there could be no doubt t in future it would be stored for irrigation poses; there would be great reservoirs formed on river like the anicats in Southern India, and water would thence be pumped up, even on to uplands, and there would be gardens everywhere. to the malaria, he doubted if the doctors would r cure it, but the engineers would, because those had been in India knew very well that malaria se from putrefying vegetation, which again arose n stagnant water, and when the land was drained malaria would disappear. He had no doubt that in e they would cure the rinderpest, and so by degrees e would be a great improvement in sanitation, and extension of European habitation supported by a ng native population, which, no doubt, would increase and multiply under the human and wise administration of the Chartered Company. With regard to the strictly financial and economic aspect of the question, he could assure the Europeans in South Africa that the commercial world was watching their enterprise with the deepest interest. If they were successful the supply of gold would increase, which would rectify the relative value of gold and silver, the disturbance of which had caused so much trouble in many parts of the world. The constant increase of the precious metals would, at all events, lower prices for the consuming portion of mankind. Lastly, there was the grand political question to which no Englishman could listen without emotion. Extensions of the railways were shown on maps, exhibited this afternoon, from the Cape right up to within almost measurable distance of the Zambesi, and no doubt they would be extended ere long to the river. Perhaps there might be some trouble to get across it, but when once the railway had been carried to the right bank, it would be carried on from the left bank to the Tanganyika lake. Such a wonderful thing was almost enough to make the bones of Livingstone turn in his grave for joy! He could never have imagined when he lay sick unto death in that region, that within one generation a railway would come up from the Cape to that very spot. When once the lake was reached, there would be an extension some way or other to the watershed of the Nile, and from there the route was now easy enough to the Mediterranean, so that they were not far from realising the dream of Mr. Rhodes, and of having a through communication from the Cape to Cairo, and on that route lay the region which had been so lucidly described that evening. He was sure they would all join heartily in the eulogium passed on Mr. Rhodes by the Chairman, and he could assure all gentlemen interested in the Cape, that at the present moment, despite all that might have been said, there was no name more respected and regarded by patriotic Englishmen than that of Mr. Rhodes. The imperial party regarded him as one of the men who had enlarged the British Empire and left their mark on the 19th century.

Mr. Franklin White said his knowledge of Rhodesia, though not so good as that of Mr. Wilkinson, enabled him to endorse his statement that there was a very fair field for mining open there. It was quite true that the gigantic operations in the Transvaal dwarfed the possibilities of Rhodesia, but the gold-bearing areas in that country were numerous and widely distributed, and he thought possibly in the future would prove more conducive to the general prosperity of the country than one central field, as in the Transvaal. Allusion had already been made to the great fairness of the statements put forth. Mr. Wilkinson had laid great stress on the necessity for developing the coal-fields, the railways, and the roads, but he thought the energy already shown in acquiring and developing

Rhodesia would not be found wanting in future, even to the extent of providing storage reservoirs for water. The author had been very modest in describing his travels as a pleasant picnic in fine weather, for no doubt in wet weather his experiences had not been at all pleasant, and his little remark about the vegetable garden at Geelong showed how often he must have been short of vegetables. The pictures he had shown gave a very fair idea as to the life led by those who were developing this country.

Mr. P. B. Waugh said that he had just covered some of the ground which had been so fully and impartially described by Mr. Wilkinson, and heartily agreed in his conclusions. The old workings, of which they had seen some views on the screen, ought to reassure the minds of the British investing public, because although they served as valuable indications, they were the main cause which had prevented any great influx of miners to Rhodesia, such as had been witnessed in California and Australia. Another interesting feature was the transition from igneous to schistose rocks, which the author had proved by microscopic sections, and which he (Mr. Waugh) had himself noticed in specimens he had picked up in the country. Many people considered that the gold-fields of Rhodesia were sedimentary, but there was a good deal of evidence that such was not the case, but that they were derived from igneous rocks, which pointed to the permanence of the gold veins in depth.

The Chairman then proposed a cordial vote of thanks to Mr. Wilkinson, which was carried unanimously, and briefly acknowledged.

EIGHTH ORDINARY MEETING.

Wednesday, Feb. 1, 1899; The Attorney-General, G.C.M.G., Q.C., M.P., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Beveridge, Edmund Walter, Kelly's Hotel, Bombay.
Gjers, Lawrence F., Woodlands-road, Middlesbrough.
Hill, Gray, Mere Hall, Birkenhead.

The following candidates were balloted for and duly elected members of the Society:—

Aflalo, Frederick G., Newark, Bournemouth.
Anning, Edward Herbert, 51, Bethune-road, Stamford-hill, N.
Birt, Sir William, Great Eastern Railway, Liverpool-street Station, E.C.
Campbell-Johnston, Ronald C., Nelson, British Columbia, and 86, York-street, Westminster, S.W.
Cotton, Ross, Cape Town and Surburban Elect[ric] Lighting Company, Rondebosch, Cape Colony.
Darby, John Henry, Pen-y-Garth, Brymbo, Wrexha[m].
Davis, William, Engineer's Department, St[ock] Exchange, E.C.
Grugeon, Charles, 49, Wickham-road, S.E.
Hartmann, George H. J., Newlands, Thames Ditt[on], Surrey.
Herman, Benjamin Richard, McLeod-road, Karac[hi], India.
Immisch, Otto Claude, 102, Tollington-park, N.
Kenward, James, 43, Streatham High-road, S.W.
Marsden, Miss Kate, 11, Redcliffe-gardens, S.W.
Mumford, Arthur George, Culver-street Ironwor[ks], Colchester.
Nicholson, H. Godfrey, Bellevue, Montenotte, Co[rk].
Preston, Edward Stuart, M.A., 63, Drayton-garde[ns], South Kensington, S.W.
Regan, William Frederick, 41, Threadneedle-stre[et], E.C.
Ridley, Henry N., M.A., Botanic-gardens, Singapo[re], Strait Settlements.
Steel, Charles, Great Northern Railway, King['s]-cross Station, N.
Stewart, George Lawrence, M.A., Queen Anne['s]-mansions, St. James's-park, S.W.
Stobie, Harry E., Grand Junction Railways, Coc[k]-house, South Africa.
Waterhouse, Colonel James, Oak-lodge, Eltha[m], Kent.
Webster, Arthur Harold, Brooklands, Riverhe[ad], Kent.

The paper read was—

THE COST OF MUNICIPAL ENTERPRISE.

By Dixon H. Davies.

Synopsis.

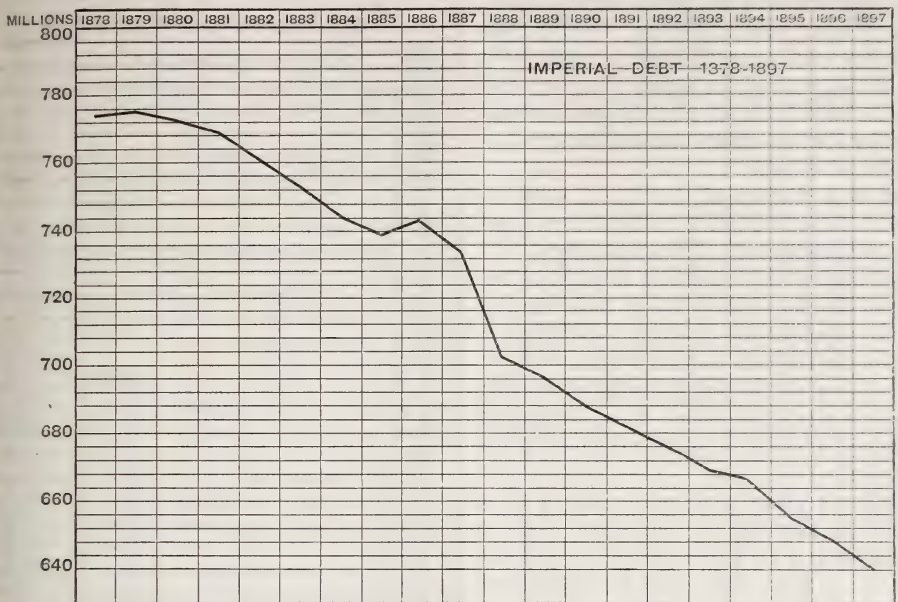
General economical principles of limitation of St[ate] functions applicable to Municipal Government as well [as] Imperial.—Relative fiscal importance of Local and Impe[rial] Governments—Representative check upon local expendit[ure] inoperative and insufficient—Growth of proper Munic[ipal] functions requiring all the attention and resources of [Local] Authorities—Repressive effect of Bureucracy, lacking b[oth] the stimulus and restraint of private enterprise. *Four ar[gu]ments in favour of Municipalism.*—(1) Cheap money—[(2)] Community entitled to profit of communal service—(3) Sor[did] motives of private enterprise—(4) Private Monopolies [ob]jectionable. Governments will not take a risk and can[not] invent, therefore Municipal enterprise tends to stagnatio[n]. Speculations on the results of such stagnation—Co-operat[ive] Societies *v.* Trade Unions—Municipal . . . . . . interfere[nce] with electricity—Its oppressive proceedings analogous [to] the abuses of the old Corporations, therefore dangerous [to] our modern Municipalities themselves, for such a po[licy] alienates public confidence—The warning of Milton.

The laws defining the limits of state actio[n], to the elucidation of which so much of the be[st] thought, both public and private, of the prese[nt] and the two previous generations has be[en] devoted, have by this time received a fai[r]

neral acceptance by our imperial authorities. is now recognised that Parliament cannot elf initiate the energies of the nation, nor pply the spirit of adventure. These develop-

aims at in this regard is the preservation of the open door, the maintenance, that is, of a favourable medium of security and liberty within which the free activities of an indus-

FIG. 1.—IMPERIAL DEBT, 1878-1897.



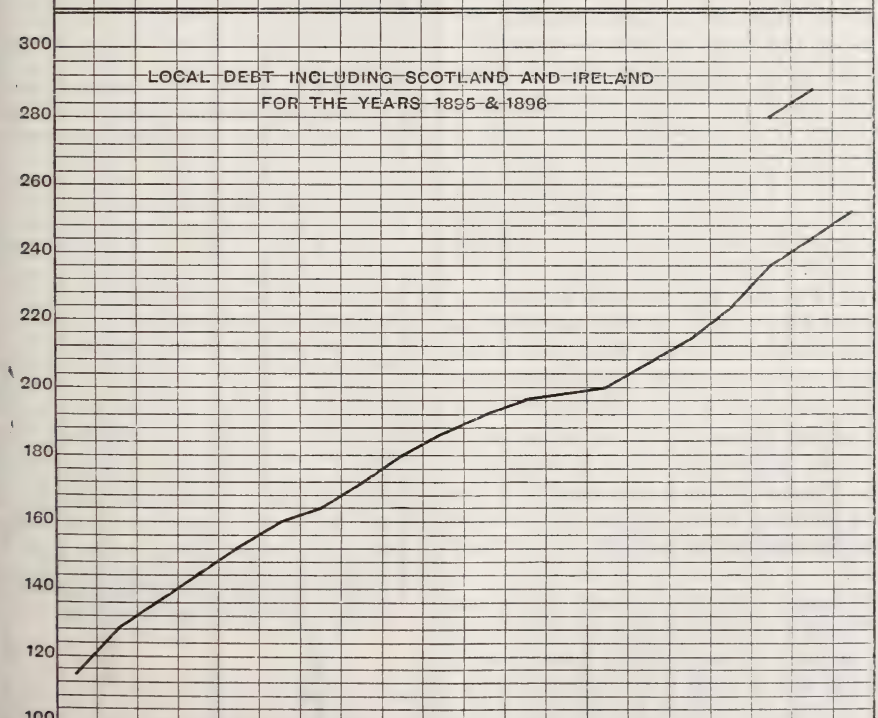


FIG. 2.—LOCAL DEBT, 1878-97 (INCLUDING SCOTLAND AND IRELAND, FOR THE YEARS 1895 AND 1896).

ents and qualities must be the product of the rains, and the enterprise of the people themelves. All that the Imperial Government

trious and adventurous people can (whether at home or abroad) operate without let or hindrance. It is true that it is the fashion of

certain speakers and writers, who aim at cheap popularity by appealing to the shallower instincts of the uninformed, to disparage these doctrines of free trade, of fair field and no favour, but notwithstanding proposals seductive to class interests, the preachings of Adam Smith, Stuart Mill, Cobden, Bright, and Herbert Spencer, have taken such a deep hold of the intelligence of the nation that they may be said to have been adopted as fundamental maxims by Parliamentary economists of whatever political colour.

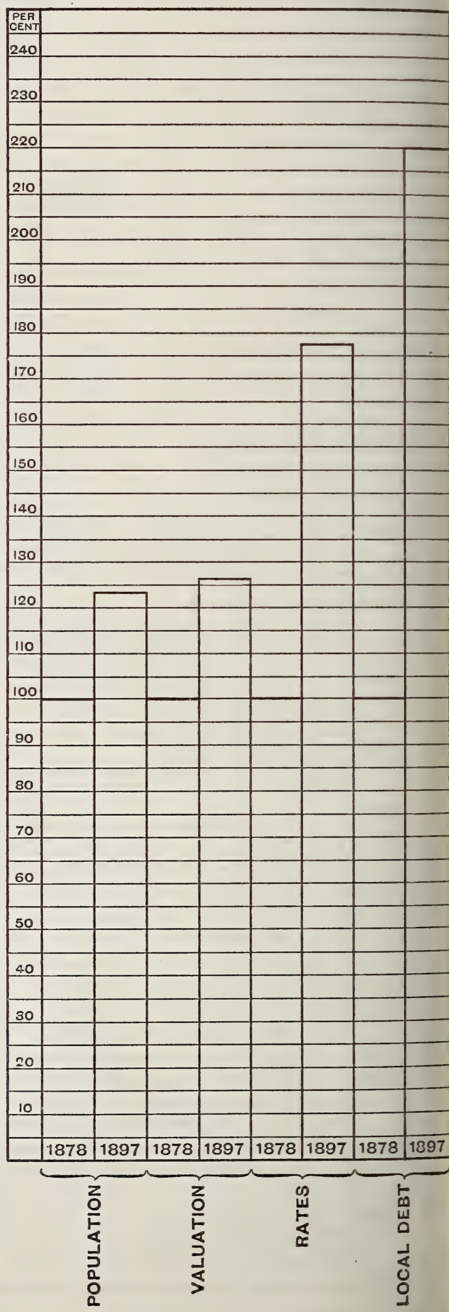
There is a portion of the State, however, into which these important truths do not seem to have yet permeated. The local administrative authorities are as much a part of the State as the imperial. They have similar rights to regulate the conduct, and tax the pockets of the subjects as has Parliament itself. Indeed, it is probably not generally recognised how large a part of the State these authorities constitute if measured by their relative fiscal importance.

The Charts given in figures 1 and 2 show the relative amounts of the debt imposed upon the country by Parliament and the local authorities respectively, and the contrasted rates of decrease of the imperial, and the increase of the local burdens, respectively, during the twenty years from 1878 to 1897, and while the imperial debt has fallen from £775,000,000 to £641,000,000 (a deduction of £134,000,000) the local debt has more than doubled itself by an increase of £138,000,000, and it now amounts to the enormous sum of £252,000,000, or, allowing for the accumulated sinking fund, £245,000,000 sterling?

The rapid growth of these local liabilities is still further illustrated by another set of figures which are exhibited on Chart No. 3, and which show that during the past 20 years the local debt has increased 120 per cent., and the annual amount of local taxation has increased 77 per cent., against an increase in the population (the Paymaster who has to meet these increasing burdens) of only 23·6 per cent., and in the rateable value of his property of only 26·7 per cent.

These figures relate to the whole of England and Wales, including the country districts whose authorities have hitherto been content, mercifully, with a much more modest conception of their functions than the municipalities. If we take the great towns by themselves (which should give us, on the principle that what Manchester and Birmingham think to-day England will think to-morrow, a more trustworthy indication of the future) the figures of the local debt appear to be more serious still. Well might a citizen in Manchester cry to his local governors, "The State has chastised me

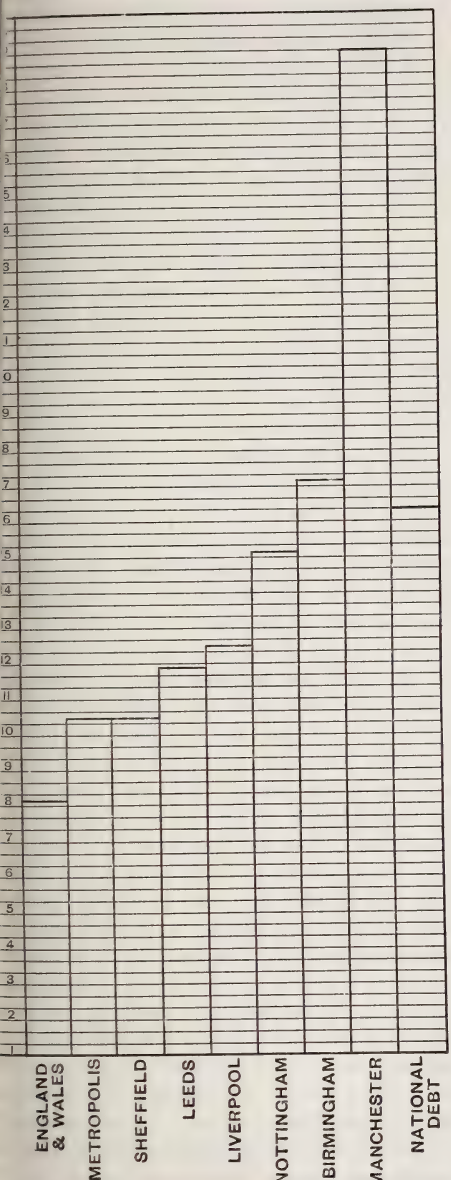
Fig. 3.—Increase of Rates, Debt, Population and Valuation, 1878 and 1897.



with rods, but ye have chastised me with scorpions," for while his debt to the nation is only £16 6s. 9d., his debt to the municipality

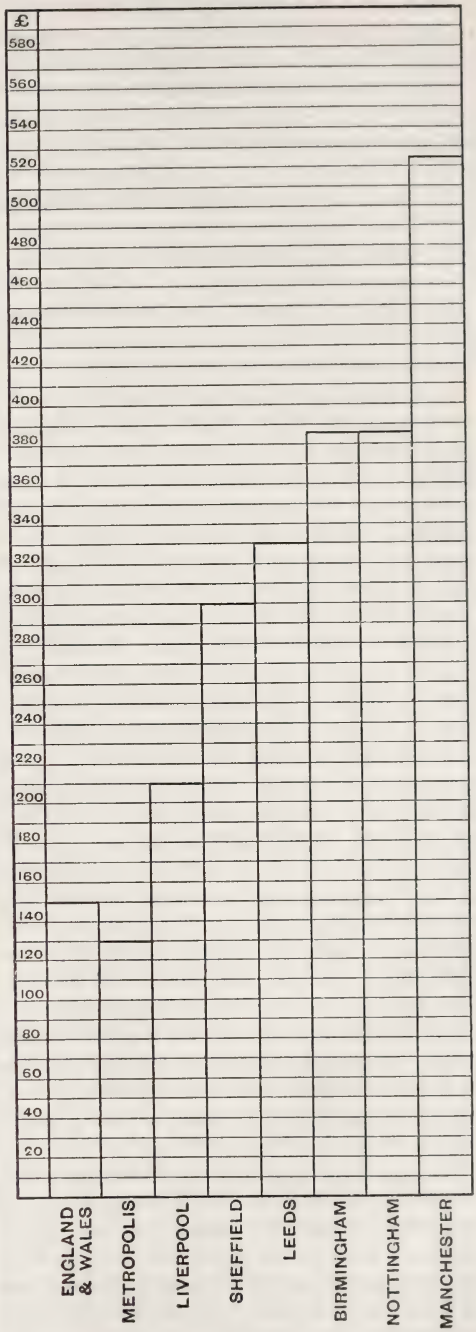
{29 1s. 4d. (see chart No. 4). The comison of the local with the national debt is e startling when the relative ages of the are recalled, for whereas the vital need of nation's defence and other imperial

. 4.—NATIONAL DEBT PER HEAD FOR 1896-7.



ecessities throughout centuries are covered -day by a debt of £641,000,000, these local rdens, the creation of the last 30 years' ready amount to £252,000,000. It must be emembered that the national debt is not ally a debt at all. There is no liability on the State to repay the principal. The reverse is the case with regard to local debts. If we except some few stocks which are only

FIG. 5.—AMOUNT OF LOCAL DEBT PER £100 OF RATEABLE VALUE.



redeemable with the consent of the holder, these moneys are real loans repayable at fixed periods, whether the assets on which they have

been expended continue to exist or not, and independently of the success or failure of the works for which they have been raised, and they constitute therefore a most serious and continuing hamper upon the taxable margin of the nation's resources, the margin which it is of high importance to conserve as far as possible intact as the nation's war-chest. Further, whereas the wisdom of the imperial legislators has been devoted throughout the late years of prosperity to the reduction of the country's liabilities on national account by the systematic redemption of the annuities, the local legislators have been steadily augmenting the liabilities of their citizens. To such an extent is this the case that if the same rates of decrease and increase are maintained for another 20 years the local liabilities will exceed the national debt.

It is sometimes said that, as these liabilities are imposed by representative authorities, the matter is in the citizens' own hands. But this does not seem to be a sufficient answer. To a large extent the representative system, though existent in form is in practice inoperative in regard to these local bodies. They are so numerous. In addition to Municipal Corporations there are County Councils, Parish Councils, District Councils, Boards of Guardians, School Boards, Highway Boards, Burial Boards, Harbour Boards, Vestries, Commissioners and probably others. The consequence is that not one householder in a thousand understands the machinery by which he is governed, or can afford the time to find out how to exercise his franchise. All he knows for certain is that the rates grow heavier year by year, and that they must be paid, and he pays and grumbles. He does not vote. To such a state of wearied apathy have the voters been reduced that ratepayers' associations are common for the purpose of checking the proceedings of the elected representatives, and a "Citizens' Sunday" has been instituted in London in order to arouse the enfranchised townsman to a better sense of his growing responsibilities.

But, apart from this, the representative check would not be sufficient even if it were in operation. The House of Commons is also representative, and yet the power of Parliament to levy taxation is much more restricted than that of the local authorities. In the first place, the imperial finance is really under the control of the members of the House of Commons for the time being, because the liabilities of the year are (apart from war responsibilities of the past) provided for out of the taxation of t year as proposed by the annual budget, where the local liabilities are mainly met by loa spreading over a period of twelve to six years, over which, once undertaken, the cou cillors have no control. Besides, by t standing orders of the House of Commons, is well known, no grant of public money ca be made except upon the initiative of t responsible Ministers of the Crown, and aft discussion in Committee of the whole Hous The value of these restrictions is probab appreciated by no one so much as by t members of Parliament themselves, for were possible for a member of the House to rise his place, as a member of the London Coun Council frequently does, and advocate son grand new scheme involving the immedia expenditure of millions of public funds, o legislators would be the perpetual prey of hungry pack of place seekers. Even as thin are, it is rumoured that the life of a memb for, say, a dockyard constituency, is not a unburdensome existence. The member of corporation on the contrary, has no such saf guards on which he can rely. Probably business himself, and surrounded with busine friends on whose good will he is to a great or less extent dependent, he has constantly run the risk of offending some of them if h affects a rigid adherence to economy, and th mixing up of his relations towards the workin class, on the one hand as master (for the co poration is often the largest employer labour in the town), and on the other hand a representative, must make his position a guardian of the public purse a difficult on Surely to leave the corporation surrounde with these direct incentives to extravaganc without any adequate check on their power t expand their functions and increase the borrowing is, to say the least of it, unwise.

Let us for a moment consider the Unite Kingdom in the light of a banking compan with its head office at Westminster ar branches in every town. We find that at th head office the rule, founded on the experienc of centuries, is that no loans are granted out the funds of the shareholders except upon th unanimous recommendation of the managin directors approved at a full Board meeting while at the branches (which the managin directors never visit, and the affairs of whic the Board give no attention to) are engaged o a policy of extension, to meet which loans ar being undertaken equivalent to those at th head office, and threatening to involve th

[enti]re resources of the proprietors, without [any] of the restrictions which long practice had [imp]osed upon the more responsible chiefs. [Sure]ly the shareholders should say to the [boa]rd "you must give these local managers [o]ne, a rule to limit their enterprising tenden[cies]," and one rule would certainly be "avoid [a]le risks, lend money upon sufficient security [y]ou like where you are sure of getting it [bac]k sooner or later in meal or in malt, and in [the] meantime sure of getting a revenue upon [it, b]ut on no account embark the funds of the [ban]k upon the chance of an adventure which [ma]y or may not succeed. Leave all such risks [to y]our customers; let them have the profits as [wel]l as the losses of them."

[I]f this would be sound policy for a bank [fina]nce, why is it not so for national finance? [Th]ere are many reasons in favour of its [ad]option. The portion of the local debt at [pre]sent invested in trade enterprises is, [ac]cording to a recent writer,* about one-half [of] the total. The rest of the expenditure has [bee]n upon matters of public health, improve[me]nt of public streets, provision of public [wo]rks, and the like, which are admittedly [un]suited to private enterprise. It is evident, [ho]wever, that the debt cannot be pulled down [on] this side. The increasing standard of [pu]blic comfort, the increasing demand for [san]itation, and so forth, will continue to [im]pose upon our local authorities duties of an [on]erous and costly nature which are well [wi]thin their proper arena. Indeed, is it not [th]e constant cry that these duties are in[su]fficiently attended to? Witness the clamour, [ev]en, alas! in vain, for the municipal dust[ca]rt. In a recent and most able address [de]livered before this Society by Sir John [W]olfe Barry, Chairman of Council, a strong [ca]se was made out for the immediate ex[pe]nditure of millions upon a new system of [th]oroughfares for the road traffic of London. [Th]e urban and suburban railways had been [wi]dened, and new lines constructed since [18]58 (Sir John said), at a total cost of [so]me £60,000,000 sterling, while the public [au]thorities had not spent a tenth-part of that [su]m upon the not less important public high[wa]ys. These necessities must continue to [gr]ow, and if for no other reason than that [th]ese very important and increasingly onerous [du]ties should not be neglected, it is desirable [th]at whatever can be should be left to private [tr]aders. Where a tub can stand on its own bottom, do let it do so, if only because you have so many tubs whose inherent equilibrium is unstable, and which are bound to exhaust all your collective stability to keep them right end up.

The worst part of trading adventures for a corporation is that there is no closing their capital account. Take the case of electricity. Corporations have hitherto only dealt with this great subject in a small spirit. The total indebtedness under this head in the last published figures is only some £3,000,000, so that there is yet time to pull up. But electricity is fast advancing into almost universal use for trade as well as private purposes. If the authorities retain possession of this industry and keep pace with the needs of the future, they will have to spend £100,000,000 where they have at present spent one. Surely such a vista of capital commitment should give pause to the counsels of those adventurous spirits who, with a vicarious enterprise, are so ready to land the ratepayers in further trading risks.

It is submitted, however, that the financial aspect of this question, how fully so ever we may comprehend it, in its prospective as well as its present condition, and serious as it undoubtedly is, does not itself constitute an adequate measure of the cost of municipal trading enterprise by any means.

In addressing a deputation in 1893, the late Prince Bismarck used the following words:—

"My fear and anxiety for the future is that the national consciousness may be stifled in the coils of the boa-constrictor bureaucracy which has made rapid progress during the last few years."

The encroachment of municipal governors into the domain of commercial enterprise must restrict, and undoubtedly it does restrict, and repress individual enterprise.

It has this effect, not only by restricting the progress in the particular undertakings upon which it embarks, but also by hindering and obstructing individual speculation in other directions which the corporation have not yet undertaken themselves, but which it or some of its members apprehend they may possibly in the future desire to undertake. It is not creditable to municipal enterprise that in no less than 104 cases local authorities should have obtained, and are holding, provisional orders for electric lighting without doing anything to carry the powers into effect. It is difficult to resist the conclusion that these powers have been taken for the dog-in-the-

* "Local Taxation and Finance." Blunden, p. 19.

manger purpose of keeping companies out, and so have had a directly retarding effect restricting the growth of the towns in an important direction.

No doubt many well-meaning people have come to look on municipal enterprise as the only means apparently available by which many useful public purposes can be accomplished, and doubtless the formation of building societies, electric companies, railway companies, and other private organisations is a very difficult matter, but the very difficulty contributes both a restraint and a stimulus which are highly advantageous, and the absence of which is one of the disadvantages municipalities labour under in embarking upon trade. It is not a good thing that capital should be had for the asking. "Borrowing dulls the edge of husbandry." When money in plenty is to be had at 3 per cent., a rigid economy seems supererogatory. Again, if any portion of the community is so lethargic as to be incapable of making the effort necessary to set any such concerns which it may require on foot in a legitimate manner by private exertions, they had better be left without them, and learn the consequences of laziness. It is a wrong principle to train people to suppose that they can sit still, and that luxury and comfort will wait upon them.

There, however, are four arguments commonly advanced by the supporters of municipal trading with which it may be convenient to deal here. First, it is said that a public authority can raise money more easily and cheaply than a private company can, and that therefore to leave large undertakings in private hands is to sacrifice an economical advantage. Is there not a fallacy lurking here? Nothing for nothing is a sound rule. Depend upon it the astute persons who finance public loans take care to exact the full market value of the risk they take. If the public authority pays less for money than the company would it is because the authority undertakes a higher obligation. The obligations of a company are devoid of personal responsibility, while the ratepayer has to repay his loans as already pointed out, independently of the success or failure of the undertaking, and is in fact a shareholder in an unlimited concern. Further, the present credit of the local bodies is to a large extent the product of adventitious circumstances. It is not due to any improvement in the financial conditions of the bodies themselves, because no such improvement has taken place. Taxation is higher and cap burdens heavier. It rests, on the contrary, the thrift of the Imperial Government, whi by reducing the interest on its stock, has for large amounts of money to seek a hig return, and by annually purchasing and c celling consols, has raised the price of th to its present level. If the National D Commissioners were to suspend the operati of the sinking fund, there is not a corporati in the country that could borrow at 3 per ce Besides, the cost of borrowed money is a ve small element in the success of a tradi concern compared with personal talent. If were otherwise we should have no new fir starting to compete with established trade Indeed, the command of large capital frequently the ruin of a business. It leads overtrading. So that even if this advanta were a real one, and one to be permanent reckoned on (which for the reasons given is least doubtful), it is not of the importan commonly attributed to it.

The second argument is that if a profit c be made out of the general supply of son commodity for the community, why should n the community realise that profit for itsel We seem to have heard of this system befor in the Shetland Islands, where, as th pupil teacher told her examiner, the inhab tants earned a precarious livelihood by takin in each others washing. But the great diff culty of a corporation engaging in a trad is to hold the balance evenly between the rat payer as proprietor of the corporation work and the ratepayer as consumer. The two ar not by any means identical. In Nottingha the corporation makes a large profit out of it gas, and in one of the Committees of Parli ment last year a prominent manufacturer spok very bitterly of the feeling of the large ga consumers that they were charged unduly fo their gas in order that the rates might b relieved. He stated that the profit on the ga was sufficient to defray the entire cost of th admirable Technical University of Notting ham, so that the large manufacturers wer compelled to provide lavish educationa facilities for the town out of their own pocket for no reason except that they were for th purposes of their business the largest ga consumers. In fact, such a process is the complain stealing from the rich to give to th poor. Again, in Sheffield the corporatio have just realised a handsome profit out o the working of the tramways, and they propos to appropriate £12,000 of this profit to reduc

amount which otherwise would have to be ɪd by increasing the general district rate ɪd. in the £. But the working-class who along the tramway route are up in arms his proposal. They say that they are ɪtically the sole users of the tramway, that wering of the district rate means hardly thing to them, that the people who will efit by that will be the rich property ers. In fact, that such an appropriation he profits means a stealing from the poor ive to the rich.

uppose, in his bewilderment, the Town ncillor, thus attacked on both sides, says will not make any profits at all, "we will ice the price or the fares, so that the it shall be extinguished altogether," this ld still be unjust to the ratepayer, who s not burn gas or does not use the tram-, for he will have been burdened with an itional capital debt for the purpose of sidizing his neighbour who has commercial ds that do not affect him. Such a rate-er will say "Why should I be dragged y-nilly into a huge trading venture with a e capital in which I take no interest, and called upon to elect directors for it, and erwise spend my attention upon a thing ch I do not understand." The reasonable-s of this will be understood from the case of Liverpool electricity works, where (the ires are quoted from a recent speech of the vn Clerk) the customers of the works only nber 3,000, whereas the entire population of city—some 700,000 people—is laid under tribution or liability to provide the capital l keep the works going, a disproportion ch is surely a strong argument for the nediate disestablishment of electricity from nicipal control.

he third contention of the advocates of nicipalism is that the motives of private enture are self-seeking and sordid, and trast unfavourably with the disinterested-s of the Town Council.

here is a great deal of cant—or at best orance—in this cry: Where is the inherent eficence or nobility in those who merely enture other people's money? On the er hand, no one who has seen the carrying of a great public undertaking by private erprise can have failed to be impressed by high degree of courage, steadiness in ersity, tenacity of purpose, faith and alty, which is required to steer it through troubled waters of its early career. It is a stake to attribute the motives of such individual adventure merely to pecuniary interest. The pleasure of accomplishing a great work of public utility and of deserving public fame, of vindicating the soundness of private opinion and higher considerations also enter largely into such motives. In fact, the adventure becomes, as Leroy Beaulieu has put it, a refined species of sport. That this is so will be evident to anyone who has studied the account of Stephenson's great battle with Chat Moss, and the dogged and devoted manner in which the great engineer was backed up by the capitalists and others who were associated with him. Such mercantile adventure affords a legitimate outlet for the sporting proclivities so firmly implanted in the Anglo-Saxon race, and one of the consequences of discouraging it or limiting the opportunity for such adventure, will be to stimulate gambling of one kind or another. No doubt the reason why gambling is so prevalent in the working-class is that, as wage earners, they have no share in the risks of their business, and so have to seek other fields for the exercise of their sporting instincts. To fence off by the staves of officialdom field after field of enterprise from the adventure of the individual capitalists is to deaden commercial activity, and to atrophise those energetic faculties of our nation, which hitherto have been the mainspring of its progress. In a recent letter to the *Times*, Sir Edward Fry says:—"What is it that has made Englishmen what they are but their passion for individual freedom, their habit of acting on their own judgment and their own initiative, and their dislike, I may say their scorn, for the leading strings of official authority? Without that freedom of individual action, England can never continue to be in the future what it has been in the past." Bureaucracy cannot create advancement any more than grammar can create literature, and for our municipal governors to affect to sneer at the commercial motives of their citizens is, having regard to the mercantile authorship of our corporations, in as good taste as for a *nouveau riche* to turn up his nose at the commercial origin of his own father.

Fourthly, it is sometimes urged that certain fields of commerce are necessarily monopolies, and that it is better that the Government should be a monopolist than a private person. There is some reason for this in such a case as the public supply of water, which, as a matter of common necessity, and one connected with vital questions of public health, may

well be entrusted to the management of the civic officers, more especially as it does not involve any manufacturing risks, and cannot possibly be replaced by another article. But in other matters this cry of monopoly is only a pretence by which people are induced to concur in the municipalisation of various trading undertakings. That such concerns are bound to become monopolies in the hands of the corporation may be admitted, for the whole power and authority of that body is used to defend them as such, and to prevent any one else conducting a competing trade which, but for the corporation, they would be entitled to do; but to say that they are monopolies when they are in private hands is an abuse of the term. They are only monopolies so long as by reason of their efficient service, or of the apathy of the community, the public do not choose to make the effort necessary to establish a rival undertaking.

What ground is there for alleging that in private hands such trades are monopolies? Because of their magnitude or their territorial stability? This merely means that those who allege it have not imagination sufficient to conceive how such undertakings can be duplicated. In the thirties everyone believed that the trunk lines of railways were virtual monopolies. Had the present doctrine of the State traders then prevailed, we should no doubt have had the railways in the hands of the Government. Does any one believe that if that action had been taken we should have had by this time four main lines of railway running from London to the North, and a fifth about to be opened, each independent of the other, and engaged in the keenest competition to improve and accelerate its service so as to obtain a larger share of the public patronage? Railway travelling between London and the North has reached a pitch of convenience and luxury, even to the third-class passenger, which would never have been dreamed of even twenty years ago. A pitch of convenience incomparably superior to that of France, where the railways have been installed under Government auspices, and where the public are saddled with nearly £4,000,000 sterling of guaranteed dividends to the railway companies every year. This state of efficiency never could have been reached by a Government railway department, for the simple reason that Government never takes a risk if it can help it. Why should it do so? and yet risk taking is the parent of progress. Can any one imagine a Civil Service Department recommending the construction of a new line of railway from Bedford to London at a cost of many milli when the whole of the traffic authorities of existing line of railway between the two po asseverated over and over again that they v ready and able to deal with the whole of traffic on that route, both existing and prosp tive? Of course, the risk would never have b taken, and the Midland Railway would not h been in London to-day, and who can say w effect that deprival would have had in retard the general trade of the country. It may guessed at from the single fact that the c sent to London from collieries on the Midl system was in the year 1867 157,246 tons 1869 after the opening of the extension London the Midland carried 760,000 tons coal to London, a tonnage which has gone increasing ever since till it now reaches ab 3,000,000. Surely this instance shows h serious must be the effect of restricting priv enterprise, for the results of such enterp indirect, obscure, and not to be foreseen, of much greater importance than the di and calculable results.

Another deficiency in Government municipal enterprise is that it is non-invent A Government never invents anything, n itself starts anything new, and is very slow adopt inventions of other people. The P Office did not invent railways, or telegrap or telephones, or boy messengers. Th with more or less reluctance, adopted th inventions from outsiders. Steam was introduced into our warships till years afte had been used in the mercantile mar Hydraulic lifts are conspicuous by their sence in the public buildings of London, the metropolitan police have not yet learnt use of the telephone. It is natural that should be so for a Government departm (whether civil or municipal is immaterial) i effect a huge machine, in which the mem are subordinated one to the other in arranged succession like the parts of machine. This gives stability and preci to the whole; it does not give indivic freedom. Each member of the departm must of necessity confine his activities to particular channel assigned to him in general design of the machine. He must no account strike out a line of his own, nei can the machine itself operate except in pre-ordained groove. It is obvious that vention, the initiation of new methods, whe mechanical or social, is not a crop that grow in a soil of this kind. Such things the product of free and independent thou

; clear, therefore, that a system of bureau-
:y tends not to progress, but to stag-
on: to the fixing, that is, of ideas at their
ting level of development. It may be able
arry on a simple trade such as the supply
vater, a commodity of universal necessity,
ch, therefore, needs pushing cannot ever
eplaced by the advancement of science, and
be managed on a system of strict routine,
in any branch of industry which is of a
oile character, and which depends on the
cation of the public, and the tempting of
tomers, the private capitalist who under-
nds his own business and is free to conduct
n his own way without having to reckon
h the opinion of a host of other people who
w nothing about it must have an incalcul-
e advantage. To attempt to presurmise how
stagnating tendency inherent in municipal
erprise will operate must necessarily be
some extent speculative, and, for sheer lack
magination, must fall short of the realisation.
e probable effect may be noticed: our
nicipalities, naturally on account of their
nocratic basis, and very properly on all
asions, take a great interest in the welfare
the working-classes. They consider they
t conduce to this welfare by supporting
regulations of the trade unions. There
1 be no doubt that these bodies have been
great service in raising the condition of
workmen, but it is equally certain that
ne of their methods are infected by gross
nomic error, and have tended not merely
the raising of wages, but to the restriction
the production per head. The prevalence
these errors, and the serious results of
recent industrial wars in which the
de unions are ranged on one side, and
employers on the other, have set thought-
men in all classes searching after some
v form of industrial organism which will
e the men out of the position of mere
ge earners (to the conservation and pro-
tion of which position the efforts of the
des unions are directed) and make them
tners in the whole produce of their industry.
e germs of such developments have already
wn themselves in the co-operative manu-
tories, and in the labour partnerships which
ve, in some instances, made promising pro-
ss with every indication of success in the
noval of the fatal rivalries referred to.

The evolution of such new collective fabrics,
devoutly to be wished by all friends of the
rking-classes, and by all patriotic citizens,
just one of those improvements which experience and theory show to be impossible of development in the sterile medium of government routine. Further, the action of the trading municipality, always insisting on trades union regulations being observed, not only in its own works but even by the manufacturers or contractors who deal with it, does much to hamper the free spirit of experiment in these directions, and to retard the operation of those spontaneous tendencies which in an open market would work towards the accomplishment in due time of such new industrial plans.

There is no need, however, to draw upon the imagination to illustrate the deplorable effects of the enslavement of free energies which results from handing over an industry to municipal enterprise. We have one existent example of it in the state of the electrical industry.

How is it that this country, which taught the world the use of steam, should be so backward in electricity? How is it that whilst great systems of electrical power transmission are common in America, in Italy, in Germany, in Austria (constituting as such systems do, an important new development in the division of labour, by enabling the small workman in a remote village to obtain his power on tap as it were, and so to produce almost as cheaply as can be done in the great steam workshops in the town), Englishmen are content with insignificant installations in monopolised areas? How is it that while English machinery in the mechanical departments still holds its supremacy at home, as well as abroad, in electrical matters, we have to gives place to other nations, and the whole of the plant for the electric traction of the underground railways of London is being ordered from America, and also that for the tramways of Leeds, Liverpool, Sheffield, of Gasgow, and of many more towns that can be named? Surely this state of things can only be accounted for by the unwise action of the Legislature in disconraging and restricting the enterprise of the capitalist and in committing this promising industry to the sterile and monopolist hands of municipal enterprise. What is the history of this subject?

Parliament yielded to the fears of gas-owning corporations (municipal adventurers are always protectionists of the most timid order) and the Electric Lighting Act of 1882 was passed. Under this Act the municipal authorities were enabled to obtain power to supply electricity under license or provisional order

from the Board of Trade, but private capitalists who might apply for such power were subjected to two disadvantages, first they had to obtain the consent of the local authorities, and, secondly, the municipalities could, at the end of the 21 years, step in and acquire the undertaking at the then value of its material effects without paying anything for compulsory purchase, or for prospective profits, or for the cost of pioneer and educational work. In effect, therefore, municipal enterprise was encouraged to embark in this promising field, and every obstacle was thrown in the way of private enterprise doing so. The result was of course that the discouragements were too great for private adventurers to encounter, and they soon left the business alone. The municipal trader, in spite of the legislative encouragement, remained true to his tradition of taking no risks, and of avoiding new inventions. He sat down, and did nothing, and the industry stagnated until 1888, only one provisional order having been granted in the previous four years. Parliament then thought it time to interfere, and passed an amending Act by which, while the encouragements to the municipalities were not one bit abated, the obstacles to a private enterprise were partly removed by the extension to 42 years of the period during which the concern was exempt from expropriation by the authority.

Still municipal enterprise stagnated, but commercial adventure made a fresh start, and almost all the existing electric stations were established in London, in Liverpool, in Sheffield, in Nottingham, in Birmingham, and all over the country by electric companies. In many cases the undertakings of these companies have since been acquired by the town before the right of compulsory purchase matured, at of course a handsome price, for a municipality can never drive a good bargain in an open market, and with the tardy advent of the municipal trader his monopolist tendencies begin to assert their mischievous influence. There is not of right any monopoly in electric supply in this country. The first section of the Electric Lighting Act of 1888 reads as follows :—"The grant of authority to any undertakers to supply electricity within any area whether by license or provisional order shall not in any way hinder or restrict the granting of a license or order to the local authority or to any company or person in the same area."

Whenever electric stations belonged to companies the local authorities were most anxious to take advantage of this section, and to promote competition. They readily gave th consent to two or more rival companies wor ing together in the same area. In London, instance, there are two electric compani competing against each other in every paris except the City, and in Westminster there a three. But what was sauce for the company goo was by no means to be sauce for the municip gander. When the means of insulating high te sion currents became improved, it was discover that the parochial limits (which were fixed are told in the time of Alfred the Great) d not form a scientific division for confining peculiarly elastic and transmissible forc Some parties therefore proposed, in full relian on the section of the Act of Parliament abo quoted, to establish electric transmissi systems on a much larger and more mode scale than has hitherto been known in th country, and, in consideration of the economi that would thereby be effected, to subject the selves to a maximum charge less than o half the rate which the corporations we authorised to charge, and were, as a gene rule, charging for the electrical unit.

This interesting and novel proposition w submitted to Parliament last year. No mon poly was sought for the Company, who mere wished to trade in competition with any exi ing stations, just as a new railway seeks pow to compete in the carrying trade. The rig to disturb the streets was confined to cas where the authorities refused, unreasonab facilities for the deliverance of the Company wares through the Corporation's wires. T proposal was welcomed by the trading co munity as one would have expected. T Chambers of Commerce petitioned in its favo and no one opposed it except the municipaliti The nature of their objections is sufficien indicated in the following recent resolution the Municipal Corporations Association, pass in reference to this very Bill: —"That th Association affirms the principle that wh local authorities have, with the sanction Parliament, established or are in course establishing undertakings for public bene and have not failed in their duties, it is r right or expedient that powers should granted to companies to compete with them

Surely here we see the municipal trader his true colours. He does not wish to trade the same way that any commercial man trad facing difficulties as they come, contendi with his rivals whoever they may be, ada ing himself to new conditions, scrapping h existing plant as soon as it is superseded, a

stituting more efficient plant often at great rifice. Your municipal trader won't hear scrapping superseded plant. He wants tection for the ratepayers' trade. If science shown that he is on the wrong lines, and made an improvident investment, so much worse for science, which must go to the wall ore the necessities of municipal trading. ience must wait until his machinery wears t, that will be quite time to introduce ything new.

The Bill, however, having in principle re-ived the approval of a Joint Committee of e two Houses, was passed by the Select mmittee of the House of Lords. At both ese inquiries the corporations were strongly presented, and clauses were inserted for e protection of their interest. Not content th this, however, these bodies continued their stility, and took the course, unusual in the case a private Bill, of organising a strong opposi-on to its second reading when it reached the cond House. There was thus presented the range spectacle of the corporations opposing e granting of facilities to traders whose ad-nt to their town their own Chambers of Com-erce were actively supporting, and whom the me corporations would, as they candidly ad-itted, have themselves cordially welcomed had ey appeared a year or two earlier, before they e corporations had embarked in the electrical usiness. The opposition was conducted not the usual way, each town upon its own ottom, but by a kind of centralised union of orporations, called the Municipal Corporations ssociation. This body raises its funds for uch proceedings by a rateable levy over the hole of the affected towns, so that although stensibly preserving its local character, the pposition is centralised, and rendered un-menable to local influence. Further, such an rganisation wields a power which, for the urpose of a second reading opposition in the Commons is most formidable. For the Associa-ion calls upon the corporations all over the kingdom to bring pressure upon their respec-ive borough members, so that in this case, which could not affect the interests of a single person north of Barnsley or south of Derby, the member for a borough in the north of Scotland, and the member for one in the extreme south of Ireland, would be whipped each by his own town clerk, to vote against this private Bill. When it is borne in mind how great (and, speaking generally, justly great) is the Parlia-mentary influence of the corporations, whose councillors are elected very often through the same organisations as are employed for the political elections, it can readily be conceived how great a bar to the initiation of an enter-prise which requires Parliamentary sanction is the mere risk of having to face such an opposition. It is hardly too much to say that such a one-sided use of the united power of these local bodies (power granted, be it remembered, for the common good, not for the protection of selfish interests) for the purpose of stifling a new enterprise at its birth, and so securing for themselves a monopoly which they would not otherwise be entitled to, savours more of oppression than of fair dealing. Now oppression is not to be tolerated on the part of our local bodies. If we were capable of tolerating injustice we should cease to be a people worthy of free institutions, and if thr effect of the acquisition by the corpora-tions of these trading undertakings is to put partiality in the seat of authority, then the cost of municipal enterprise will be much more serious than any that has yet been con-templated.

Surely the corporations have forgotten the sins whereof they have been purged. It was because of the monopolies and restrictions which the old self-elected corporations im-posod on the trade of the towns that, strong as they were in Parliamentary influence, (for the old corporations actually elected the borough members themselves), they for-feited the public confidence, and they were abolished by the Act of 5 & 6 William IV., cap. 76, section XIV. of which read as follows :—" Be it enacted that, notwithstand-ing any custom or bye-law, every person in any borough may keep any shop for the sale of all lawful wares and merchandize by wholesale or retail, and use every lawful trade, occupa-tion, mystery and handicraft for hire, gain, sale or otherwise within any borough." The consequence of this new policy of freedom for industry is the extraordinary growth of popu-latlon and resources which has succeeded the reform. But the oppressive treatment of the electrical traders would seem to indicate a reactive tendency towards the old mischief again.

All this points to yet another danger of municipal trading, a danger that is to the stability of the municipal institutions them-selves. These institutions, which are the most ancient, and, as they exist to-day since their constitution was broadened by the Act referred to, among the most efficient examples of the self-governing faculties of our

race, are deserving of our uncompromising support. The towns are, besides, dependent upon them to an incalculable extent for some of the first necessities of modern life. It is therefore a duty imposed on all by self-interest, as well as by gratitude and patriotism, to point out fearlessly the insidious error which is creeping into the practice of these bodies, and to use every effort to arrest it before the decadence becomes irretrievable. It would be wrong to overlook the serious state of the municipal institutions of America, arising, as competent advisers tell us, from the unlimited enlargement of the functions of the Government. The consequence is that public employment is excessively multiplied, and the municipal debts have risen to colossal dimensions. The affairs of the cities are left to professional politicians, and are conducted in such a nauseous atmosphere of class corruption and party trickery, that the better class decline to have anything to do with them. A distrust of the servants and representatives of the people is everywhere manifest.* We are a long way from such a state of things in this country, but can it be doubted that this ambition to embark in trade will be injurious to the corporations, for their efficiency must depend, not upon the profits which they may be able to make out of their various trading advantages, but upon the degree to which they can absorb into themselves the energies of the most capable citizens? Is a course of action which puts them in competition with their own traders, which results in the imposition of something like an octroi duty upon a commodity that is fast becoming the necessity of every manufacturer calculated to secure the respect of the trading community? Further, is it calculated in the long run to secure the respect of the working class? The expenditure of public money in a district; the establishment of municipal works; the employment of large numbers of the ratepayers at municipal wages; these are very popular things while they last, but they are also very difficult things to stop, for they necessarily create in the minds of the more ignorant of the ratepayers false ideas of the function of the local government. How can you blame the wage-earner if he comes to think that it is the duty of the municipality to find employment for him, and how can you blame him if, when the inevitable disillusionment comes, he is disappointed and disgusted on finding that he is mistaken? Municipal trading is thus infected with the commun[ic] poison. It begins by alienating the confid[e] of the manufacturers, and ends by aliena[g] the confidence of the workmen from institut[s] which, so long as they confine themselve[to] their proper functions, are productive of s[h] great good to the country. Surely, theref[ore,] the corporations would be well advised [to] confine their functions to those import[ant] public matters in which all their constitue[nts] are equally interested, and which must [of] their nature be performed by the ratepayers [in] common, and which involve no taint [of] partiality, or suspicion of class bribery, su[ch] are the administration of justice and poli[ce,] the care of the public health, the provis[ion] of parks and open spaces, and so for[th.] Let them leave to private enterprise whate[ver] private enterprise will undertake, keepi[ng] themselves in an impartial position, so th[at] they may secure the unsuspicious loyalty, a[nd] obedience of all the traders to the regulatio[ns] which they impose upon them for the prote[c]tion of the common interest. Let them adh[ere] to the spirit of the constitution of Alabam[a] which declares "That the sole and only legi[ti]mate end of Government is to protect the citiz[en] in the enjoyment of life, liberty, and propert[y] and when the Government assumes other fun[c]tions it is usurpation and oppression."

A policy of antagonism to the trading com[]panies on the part of our Corporations would [be] an undoing of their own work. The immedia[te] cause of the active commercial energies [of] which so much jealousy has been expressed [is] the liberty which has been secured to th[e] individuals in the towns by municipal instit[u]tions, "that liberty which is the nurse of a[ll] great wits," and for these institutions to inte[r]fere with and repress trading liberties is bot[h] unnatural and self-destructive.

The following words, addressed by one of th[e] great apostles of liberty to the Lords an[d] Commons of England, so long ago as th[e] first half of the 17th century, are sti[ll] pregnant with wisdom worthy of the attentio[n] of our reformed municipalities on the eve [of] the 20th: —

"Ye cannot now make us less capable, le[ss] knowing, less eagerly pursuing of the truth, unles[s] ye first make yourselves, that made us so, less th[e] lovers of our true liberty. We can grow ignorar[nt] again, brutish, formal, slavish, as ye found us, bu[t] then ye must first become that which ye cannot be[,] oppressive, arbitrary, and tyrannous, as they wer[e] from whom ye have freed us."*

* See Lecky on "Liberty and Democracy," vol. i., pp. 80–86. American authorities there cited.

* Milton's "Areopagitica."

he statistical tables are the work of Mr. Ernest ies, of the London Stock Exchange, and for n, and for many valuable suggestions on other ts of the paper, the writer expresses his thanks. still larger contributions which have been levied the works of Herbert Spencer, of M. Leroy aulieu, and Professor Lecky, will be evident to any dent of those distinguished authors. To them, he, writer, respectively tenders his acknowledgments. the town clerks of various cities and boroughs o have supplied statistics with the courtesy aracteristic of their office, thanks are also due, and o to Mr. James Watson, the actuary of the glish and Scottish Law Life Office, for his kind vice and assistance; and in particular to Mr. H. aham Harris, and to his firm, Messrs. Bramwell and arris, of Great George Street, Westminster, S.W. t only for most valuable aid on all points, but for original idea of the paper.

DISCUSSION.

The CHAIRMAN said Mr. Davies had brought forard in a most attractive manner a subject which, at st sight, appeared very dry, and had not only lieved it by pointed and humorous observations, it had presented some very serious points for conderation. As he was unable to remain until the ose of the discussion, he would make a few remarks hich occurred to him at once. The Tables on the all would, he hoped, be reproduced in the *Journal*, they were very valuable, but he thought their value ould be enhanced by a further subdivision showing e amount of local debt which had been incurred for hat might be broadly termed trading purposes. Whatever might be said as to the profit made out of ndertakings such as gas or tramways, worked by orporations, his belief was that if the matter were hrashed out, it would be found that the burden on he ordinary ratepayer was less where no such isks were undertaken. Of course, he did not pretend to lay that down as a fact, from personal knowledge, and therefore he thought it would be ery useful if such an addition could be made to the Tables. It was the more important, because it was stated that, according to the most recent statistics, one-half of the total local debt was due to trading risks. Valuable as the paper was, he should have been glad if Mr. Davies could have drawn some more precise conclusions as to where the line should be drawn. He had indicated one limit, viz., that corporations should confine themselves to such works as sanitation, parks, open spaces, police, and possibly water; but those limitations might be further developed. He had the strongest feeling in favour of the main argument of the paper; indeed, he thought it might have been put even more strongly. Not only was the power of a corporation to earn money as traders quite a modern development, but in the beginning of the reign it was contrary to law. He remembered arguing a case many years ago with regard to the duties and powers of a corporation which was contemplating supplying gas to outlying authorities, and Lord Chief Justice Cockburn laid it down as an axiom that, except for statutory authority, a corporation had no power to make profits. That was not a mere accident owing to the want of development of modern enterprise, but was due to a sound system of political economy, that it was almost impossible to put the burden of a trading undertaking on the right shoulders, and so to regulate the charge that you did not put a burden on those who derived no benefit. Some people still thought it would be well to have toll-gates, because then those only who used the roads would pay for them. But without going so far as that, every one could see that it was extremely difficult to make the cost of an undertaking and the charge for it exactly balance; and he did not believe any corporation could so adjust its affairs that the burden should be borne only by those who used the undertaking, especially when, as in most cases, a sinking fund had to be provided for. It was a burden on the ratepayers of to-day for the benefit of those of the future. Again, the absolute necessity of inventive competition in this kind of undertaking was of great importance to the argument. He knew of nothing in which this was more marked than in connection with telephones, electric lighting, the supply of gas, and so on. History showed what difficulty there had been in introducing economic changes, and in inducing people to discard old machinery in favour of new even where there was the inducement of greater profit. There was practically no inducement to a corporation to discard old plant and buy up new until it was worn out, and all history showed that to private enterprise and energy all the great inventions of the world were due. A great deal of cant had been talked about monopolies, and after all there was no greater monopoly than to give a corporation the sole right of supplying electricity. No local authority would be likely to give its consent to a private undertaking supplying electricity in competition with itself, but he was satisfied that competition was essential in connection with electric lighting as with any other question of supply and demand. Possibly a distinction might be drawn in favour of water, and certainly drainage was a matter out of which no profit ought to be made. Everybody benefited when the health of a town was improved. He admitted that water was very near the line, and within certain limits every one ought to require about the same quantity. He would not go into questions which were extremely important and very far-reaching, and of which they did not know what the outcome might be, such as the evils which might be created by a fictitious rate of wages being established by municipal authorities as compared with the price at which honest contractors could get the work done. Those persons who had not had to do with practical business might say

no harm was done by the present rate of wages being raised, but an end must come, and the general result on trade, and ultimately on the prosperity of the working-classes would be harmful. One point which perhaps Mr. Davies had a little exaggerated was the ease in getting money on the part of the local authorities. Though they might raise it on lower terms than a private company, they had to provide for repayment within a certain time, which a company had not, and one thing must be put against the other, but that was a point which would bear a great deal of discussion. He concluded by formally moving a vote of thanks to Mr. Davies.

Sir WALTER PRIDEAUX here took the chair.

Mr. BRYDGES said he should like to say a few words on behalf of corporations. In the first place with regard to the comparison made between the local and the national debt it must be remembered that in the case of the local debt there was something to show for it, whereas there was nothing to show for the national debt; it represented hardly anything but the expense of a number of wars which, however necessary, were only necessary evils. In the time of George IV., after the Napoleonic wars, the national debt was something like £900,000,000, though it had been considerably reduced since; and it was not like a debt which had been incurred in the purchase of assets, tangible and to a certain extent realisable. With regard to the probable increase of local debt, Mr. Davies said if it went on at the present rate, in another 20 years it would equal the National Debt; but it did not follow that because an increase had taken place in the past it would continue at the same rate in future. On the same principle, the national debt having been about £30,000,000 in the time of Queen Anne, an economist in the days of George IV. might have said that in another 100 years it would amount to £127,000,000. Half the debt incurred by corporations had been for purposes of sanitation, and the towns having been put in decent order, it might be hoped that similar expenditure would not have to be incurred again. He did not understand how half the total amount had been incurred for trading purposese if half had been spent on sanitation. Four arguments in favour of municipal enterprise had been mentioned, and objections raised to each. As to the low rate at which money could be raised, it was said that was because corporations were found to pay their debts; if so, he thought it was a very good reason why their credit was good, and there was no blame to them for that. Then it was objected that the cost of borrowing money was of less importance than the employment of talent and energy. That seemed to be giving away the whole question, if it was meant that private companies could secure superior talent, but he should think a corporation might engage persons equally talented with those who served a private concern. Then it was objected that corporations coul earn a profit because they paid higher wages, could make a certain dividend and yet inc the wages to some extent. There was a gro feeling in favour of raising the minimum ra wage, and he thought it was to the credit of porations that they had done something to re that ideal. Then it was said there was no moti in the case of private enterprise, and there was a of sneer at corporations being disinterested. No supposed a town council was disinterested on its account, it acted as trustee for the ratepayers. with regard to monopolies, he always understood the principal objection raised to them was that public suffered, and, in fact, the charges of gas other companies had to be regulated by Parliam In many cases corporations had done good wor taking over the undertakings of gas and water c panies, and he did not believe any complaint had arisen in consequence. With regard to the rise in rates, Mr. Davies seemed to think there was an limited power of borrowing, but that was so. In the first place there was the power of electors, and many candidates put in the forefron their addresses that they were advocates of st economy. Gentlemen might laugh at that, very many had been elected who acted up principle. No doubt there was a strong tendenc human nature to spend other peoples' money free but there was also a tendency in many men to ab by their principles. And if that were not eno security, it must be remembered that every loan to receive the sanction of the Local Governm Board. If there was any question about the ex dience of the expenditure, a local inquiry was he There was no danger, therefore, of money be borrowed recklessly without the sanction of the ra payers.

Mr. GRAHAM HARRIS said the paper was a v good one—too good, in fact, for there was t much in it to be appreciated on merely heari it. It was a big subject, which tempted o into all sorts of bye-paths, but he admir the way in which the author had kept to the m road. With regard to Sir Richard Webster's su gestion that a note should be added to the pa giving the proportion of debt incurred by differe municipalities for purposes other than drainag public parks, &c., &c., he thought it would very useful. He noticed that Manchester h the biggest municipal debt, and he shou imagine a large part of that was due to t Manchester Ship Canal. Whether that was a tradi concern or not, he would leave to the shareholders decide. His firm were engineers to the particul electric undertakings which had been referred t and three Bills were coming before Parliame this year, one of which he might specially refer t That was the Leicestershire and Warwickshire Bil The proposal contained in this Bill was to supp

tricity from a central station on the coal-fields an area of nearly 1,300 square miles, for lighting er, and any purpose for which it could be used; having regard to what was being done in many, America, Austria, and Italy, it was quite ain that it could be supplied at something like -fourth the rate at which it was sold at sent. The total area in that district, at present plied by the municipalities who were opposing the , and stirring up opposition all over the kingdom, four square miles, and the whole work might done by one small engine working continu-ly. They had 1,020 customers, but the whole ulation was counted by millions. The sugges-n of the municipalities was that the company uld be prevented from supplying that area, and that the millions of people in the area, including their 20 customers, should be prevented having elec-ity at the price the company were prepared to ply it at. This was a serious matter, especially ing regard to the difficulties with which English nufacturers were at present contending as against eigners.

Mr. W. M. ACWORTH thought it was hardly fair blame corporations for claiming a monopoly. ey were highly organised bodies, and they ew that even the lowest organisms had an inct of self-preservation. Now anybody o knew the working of a corporation, as tinguished from a private trading body, knew t if a corporation had not an absolute mono-y it was bound to go to the wall. He had re-ved a document which seemed very germane the question before them, viz., a summary of ich appeared in the *Times* that day. It was issued the School Board for London, and had reference a conference on assessment matters. He received as chairman of the Finance Committee of the etropolitan Asylums Board, a body of which not e ratepayer in a hundred had ever heard, though it s responsible for an annual expenditure of a quarter a million. The document pointed out that public dies had to pay 10 per cent. more than a private lividual whenever they sought to acquire land, and it they were at a similar disadvantage when king contracts for building. For the latter tement various reasons were given, and he might d one which was put to him by a gentleman who d done work in bricks and mortar for the rate-yers of London certainly to the extent of a ,000,000, if not more. He said when he made his timates for any public body he always assumed that workmen would do less work for a contractor orking for a municipality than for a private owner; did not know why they should, but experience oved that it was so. The London School Board d spent about £6,000,000 in buildings, the body represented about £3,000,000, and he believed 10 r cent. was a modest estimate of the difference in st, and that more than wiped out the advantage of which they heard so much, of raising money cheaply. He had lately read the proceedings of the Committee on the Bills to which Mr. Harris referred, and he found there were two points made by the municipalities. One was that they were entitled to a monopoly, because it was in the interest of the ratepayers that they should have it. They always made that assumption but never attempted to prove it. The other point was that they owned the roads, and that nobody else ought to be allowed to interfere with them. It had just been decided by the Court of Appeal that this claim by the municipalities was a mistake, that they did not own their roads, but only had a certain qualified control over the surface, and when an electric company without any right whatever pulled up the road and put in a main two feet deep, the municipality had no right to follow them. They were told that if the municipality only dealt with the roads, they would not be so constantly pulled up as they were by private bodies. It might be so if all municipal matters were managed by one committee; but, as a fact, he was informed that the main street of an important town was pulled up three times in one year—by the sanitary committee, the gas committee, and the water committee of the same corporation. He thought if the result of this discussion was to lead people to go behind some of these claims and examine the grounds for them, it would be greatly in the public interest. Mr. Brydges said municipal debt was not likely to increase as fast in the future as it had done in the past, but if so, he did not know what would become of the development of electricity. Here they were told that municipalities had invested three millions in electric undertakings; in America in electric traction alone not less than fifty millions was invested. If the municipalities were going to keep this business in their own hands, and were not going to increase their debt, he did not know what would become of the industry.

Mr. EWING MATHESON said it was a pure fallacy to say that corporations could borrow more cheaply than other people because they were obliged to pay their debts. They ran risks which often doubled and sometimes trebled in effect the interest they paid. The Manchester Ship Canal was largely contributed to out of the rates, and as it cost vastly more than was anticipated the money raised by the rates had to be doubled. He knew of a considerable town in the north, which built a large reservoir for a water supply, costing a quarter-of-a-million. They thought it cheaper to do it themselves because they could borrow cheaply, but when it was finished and the water was let in it all ran out at the bottom, because it was made cheaply. After ten years delay it was put right at a cost of another £250,000. If a private company had done the work, they would have had to bear the loss instead of the town. The risk was not always directly in money, but sometimes in the use of obsolete machinery. Some towns had constructed or acquired

electric installations incapable of performing the service required of them, but if a private company attempted to compete, the whole power of the corporation was used to prevent them. If it were the other way and a private company had an obsolete or insufficient plant, the corporation would go to Parliament with a very strong case for setting up a private undertaking. The question in towns was often in the hands of officials, who liked to magnify their position and keep out other people.

Mr. SYDNEY MORSE agreed with the Attorney-General that it would be well if the author could have given one or two suggestions as to how the question could be dealt with practically, as it would be a burning one in the next Session of Parliament. No less than seventy municipalities were applying either to Parliament or the Board of Trade for powers to trade in electric fittings, thus coming actually into competition with private manufacturers; and in addition to that a large number of Bills were coming forward in which municipalities were seeking to become trading corporations. Manchester was proposing to inaugurate a system of tramways within sixteen adjoining districts, in which it claimed that no company whatever should have a right to put down or work tramways. The Manchester Corporation did not say they would make all necessary tramways, but only those should be made which they approved. The practical point was how was this question to be met? One way was to oppose these Bills in Parliament, and he was glad to hear that the Postmaster-General was opposed to this kind of thing. As Parliament had already permitted local authorities to undertake certain work it was no use proposing an absolute negative, and the more difficult question remained, to what extent should they be authorised; and they could only go on the lines, how far it should be allowed. That raised a very difficult question, and he would ask all those present, and those who attended the adjourned meeting, to endeavour to give some assistance on that point. It must he admitted that no municipality ought to be authorised to do work for the benefit of other people at the cost of the ratepayers. They ought not to encourage expenditure on behalf of one section only of the ratepayers, and they should be confined strictly within their own area. If there were a scheme proposed in London which would greatly benefit Islington, it was not right that those who lived in Kensington should be heavily rated for the purpose. Health was a matter in which all were deeply interested, and therefore, there could be no question with regard to sentiment, but when it came to carrying on a big undertaking all over the country it was a different thing. If Manchester got a line of trams to the big towns surrounding them they would want next to come to London, and logically there was no reason why they should not. In the City of London they were going to fight this matter out to the bitter end, and he hoped that everyone would do their best to get Members of Parliament to take the right course in this matter, aud prevent the further extension of a very dangerous principle.

Sir JOHN ROLLESTON desired to thank Mr. Davies for his valuable paper. He was in close association with a community in which a large and important section were pressing forward doctrines of a contrary nature. It had a population of over 200,000; a large section — in addition to the nationalisation of the land, railways, and so on—were bringing forward a programme for the municipalisation of all industry. This, of course, encouraged the corporation to enlarge its system of municipal trading. In that town none of the great public works—water, gas, or tramways—were due to municipal initiative, but to private enterprise. He must except electricity, which the corporation took in hand after several companies had applied to the Board of Trade for licenses. The first Act was obtained in 1879, but until 1894 no electricity was supplied, and then it was at 6d. per unit. Since the promotion of the Bill to which Mr. Harris had referred, there was a prospect, however, of the price being reduced. The borough was the head-quarters of the boot and shoe trade, in which thousands of people were employed, and most of them supported these schemes, though a little reflection might teach them to think that, if that industry had been left to the municipality, not one pair of boots would have been made, or a shilling invested in the manufacture.

The meeting was then adjourned to Thursday, February 9th, when the EARL OF WEMYSS will open the adjourned discussion.

Miscellaneous.

NEW SURVEYING INSTRUMENT.

To devise an instrument able to record automatically not only the distance travelled by a bicycle or other vehicle but also the various directions followed during the journey and the hills ascended or descended, would be by many people pronounced an impossibility. Nevertheless a little piece of apparatus has recently been designed which appears to do all these things. The record of distance travelled, of course, presents no difficulties. The record of directions is not so simple, but, as might be expected, it is obtained by means of a compass. The needle is suspended at the top of the pathometer, as the instrument has been named, directly above the tape on which the records are taken, and is so arranged that all its movements are exactly reproduced by the stamping portion of

marking apparatus, though the act of stamping erformed independently of the needle and without urbing it in the least. The indications appear on tape in the form of fine arrows, all, of course, ding magnetic north and south. Now the run of tape represents the direction in which the bicycle els, hence the series of arrows constitutes a record he course steered. As to the third point, that of nts and declines, the problem is solved by a dulum. The pathometer is fixed to the frame of vehicle in such a way that this pendulum is free nove to and fro in the line of travel, its oscillations ng damped by the well-known method of immer- in glycerine or other viscid fluid. Against the ording tape, which is carried on a drum that is ated as the bicycle moves by the action of a icker" as in an ordinary cyclometer, there presses heel with sharp teeth, able to cut into the paper. s wheel is controlled from the pendulum in such a y that when the latter is hanging in its middle ition—as it does when the road is quite level—the cut in the tape is straight and parallel to the ges of the strip, but when the pendulum is swung wards or backwards the line is diagonal, its iquity being proportional to the steepness of the pe traversed. Hence with a knowledge of the stants of the instrument the gradients over which vehicle has passed can be easily calculated. The entor does not expect an error of more than 1 per it. in the cheaper and smaller forms, while he ieves that in larger ones carefully constructed for entific purposes it can be reduced to 1 in 1,000. e instrument is not yet on sale.—*The Times*.

ARTIFICIAL SILK IN GERMANY.

Artificial silk consists of prepared cotton or wool re and has been known to the trade under this nomination for some years. It possesses an tremely silky lustre and can therefore be employed an imitation of silk. Count Chardonnet, a French- n, the inventor of this material, converted the llulose (cotton or purified wool fibre) by a process scribed in German letters patent of the year 1884, rough nitro-sulphuric acid into nitro cellulose. He en freed the same from the acid and dissolved it in mixture of alcohol and ether. The solution thus tained, collodion is pumped through glass pipes nich are provided with extremely fine holes, and ese collodion threads are passed through warm ter (acidulated), which causes the alcohol and ether evaporate, and only the fine nitro cellulose threads main. A number of these fine threads are brought gether, slightly twisted and spooled. The United ates Consul at Barmen says that this extremely strous, but easily inflammatory—even explosive— ssue was put on the market at the time of the Paris xhibition in 1889. Owing to its great liability to tch fire, it did not come into practical use, but after this difficulty was overcome by removing the nitro groups (a process called denitrating), the harmless fibre was employed in the textile industry. By a similar method artificial silk was produced by a chemist of Augsburg, Dr. Lehner. Lastly, however, a method has been invented in which the use of the injurious nitro cellulose is omitted. Cotton waste is dissolved in copper oxide of ammonia and the solution is pumped through fine tubes. The delicate threads are passed through diluted acid, which separates the copper and ammonia, the result being an extremely fine lustrous fibre which is employed as an imitation silk. This process, which is patented in Germany and other countries, is said to have the following great advantages over those of Chardonnet and Lehner:—(1) That the manufacture as well as the product is in no way dangerous; (2) that the production is much simpler; and (3) as a consequence imitation silk can be manufactured by this process at considerably less cost.

TOBACCO IN KOREA.

The Koreans are great smokers, and both sexes and all classes begin smoking early in life and keep it up most diligently. Tobacco is not used by them in any other form then smoking. The pipe is the constant companion of every Korean man and woman. However poor an individual may be there always seems to be some method of obtaining tobacco for the pipe which he or she is sure to possess whatever else may be lacking. The tobacco used by Koreans is almost entirely home grown. Every farmer or gardener has his little patch of tobacco, much of which is very good in quality, but is injured in curing, being simply hung up under the wide eaves of the houses to dry. It is quite strong. The supply seems to be ample and the price is very low. No leaf tobacco is imported. According to the United States Consul-General at Seoul the Korean pipe is a brass bowl of fair size with a brass mouthpiece. These are connected by a hollow reed stem of from one to four feet in length, some of these stems being beautifully ornamented and all neat and light. The common people use shorter pipes for convenience in working, but all who can, affect the long pipe both for coolness and for the appearance. The mouthpieces are often made of jade, amber, or other costly material, and of late mouthpieces of clouded glass have been offered for sale at such cheap rates as to make them more or less popular. The long pipe can be smoked with comfort only when the smoker is sitting down. Accidents often occur from persons falling with a long pipe in the mouth, the stem of which is driven down the throat, through the cheek, or into the soft palate. During the reform period that followed the Japan-China war, an order was issued forbidding the use of the long pipe by the common people. Many short foreign pipes were sold thereafter, and the use of the cigarette became less

common. This order is now practically a dead letter, and the long pipe is reinstated, but cigarettes have become so popular because of their convenience, that it is said they will probably never be given up, but will increase steadily in favour. Native cigarettes of the poorest quality are made and sold at a very cheap rate. American cigarettes are used exclusively at the palace, where large quantities are consumed. Some English cigarettes are now to be found in the shops, and Russian and Egyptian brands are kept for the consumption of the European population.

THE YUCCA PLANT IN VENEZUELA.

The great staple of Venezuela is coffee, but as prices are low, farmers have been turning their attention to other plants which give a more lucrative return. Yucca, according to Consul Plumacher, of Maracaibo, appears to have a great future before it. It is a vecy productive plant, and although well known in Venezuela, no one as yet has taken any special care to develop it. One hectare (2·47 acres) of land upon which yucca is grown will produce 150 quintals (15,000 lbs.) of starch, or 200 quintals (20,000 lbs.) of tapioca. The plant is easily and cheaply cultivated. It will stand bad weather, and the dry season does not affect it, and it can be raised on any soil. The yucca will thrive on the same soil as peas, beans, and corn, and ground so utilised becomes far more remunerative than land planted with coffee. One hectare (2·47 acres) of tilled soil will produce 1,600 coffee plants. Allowing the maximum yield of coffee per plant, a hectare will produce 8 quintals (800 lbs.) of coffee, and on the same ground the yucca will yield 150 quintals (1,500 lbs.) of starch, exclusive of other crops from the same soil. The means of cultivation are primitive. Ploughs and other modern farming implements are almost unknown in Venezuela. All the work is done with old-fashioned hoes, as neither man nor beasts have been trained to use modern ploughs.

Notes on Books.

NEW METHODS IN EDUCATION. By J. Liberty Tadd. London: Sampson Low, Marston and Co., 1899.

The value of drawing, as a means of education, appears to be attracting more and more attention. For some years the Royal Drawing Society and its founder, Mr. Ablett, have been urging the importance of teaching children to draw, as a means of general education and with the object of developing their faculties rather than of training artists. And now from the other side of the Atlantic there comes this elaborate and handsome volume by Mr. T[add], of Philadelphia. According to the account given [in] his book, Mr. Tadd has been extremely success[ful in] applying in the schools of Philadelphia somethin[g like] the same principles as those which have been [advo]cated by Mr. Ablett before the Society of Art[s and] elsewhere.

The book itself is very handsomely got up [and] very fully illustrated, indeed it justifies the state[ment] on the title page that it contains "a weal[th of] illustration." Most of the pictures are from p[hoto]graphs, showing children and adults at work, an[d the] work they do on the blackboard; there are a[lso a] very large number of diagrams.

Mr. Tadd describes his whole system with [con]siderable minuteness. He first teaches childr[en to] draw circles and curves on the blackboard unti[l any] required curve or circle can be struck instinct[ive]ly and accurately, the hand being trained to carr[y out] almost automatically the idea conceived in the [mind]. The curves are then elaborated into simple patt[erns], leaves, shells, &c., and then into more compli[cat]ed designs. In this he differed from Mr. Ablett [who] regards such mechanical training as injurious [to a] child's own spontaneous attempt, and blackb[oard] drawing as unsuited for children. Next the chi[ld is] taught to draw from natural objects, and the im[por]tance of memory drawing is especially insisted [on]. There is little evidence of systematic training, eit[her in] observing or distinguishing between real and app[arent] form, shade, &c. Further data are required in [order] to form any precise idea as to the character and [mode] of production of much of the work. To j[udge] from the results shown, Mr. Tadd seems to have [been] very successful in training children; though it is [but] natural to assume that the illustrations here sele[cted] are the work of children who have a special apti[tude] for drawing, not the mere average work produc[ed in] the school. As to the merits of his system the[re is] room for much divergence of opinion, and prob[ably] experts would find much to criticise, as well as [some]thing to approve.

The same method of teaching is adopted [in] modelling and wood-carving, while the final ch[apter] gives the application of drawing to elemen[tary] science teaching, the forms of objects being impr[essed] on the students by their being made to draw [them] direct from the model, and also from memory.

SELECTED EXAMPLES OF DECORATIVE ART F[ROM] SOUTH KENSINGTON MUSEUM. Edited by [E.] Witthaus. Part I., Jan. 1899. Longmans, G[reen] and Co. Folio.

This is the first number of a publication w[hich] is intended to be continued monthly. Each nu[mber] will contain 12 plates of photographic reproduct[ions] of objects in the Museum, and the object of [the] publishers is to supply teachers and students in [art] and technical schools, designers and producer[s of] artistic and useful articles, with the best type[s of]

ıental objects for their study. It is intended :lude in the series examples of sculpture in e and stone, carved woodwork and furniture, work, bronzes, hammered and cast-iron, brass, r, and lead work, silversmiths' work, glass s, leather work, textile fabrics and embroidery, ıces.

ENT DAY METALLURGICAL ENGINEERING ON E RAND. By John Yates; with an Appendix the Economies of the Transvaal Gold-mining lustry. By Hennen Jennings. London: *Min- Journal.* 4to.

is work was originally intended only to contain cription of the engineering connected with the industry of the Witswatersrand, but its scope een enlarged in accordance with the terms of the page, and the details of the various companies ılly illustrated by a series of plates of machinery, The author, who dates his preface from nnesburg, refers to the tardiness of the Transvaal rnment in encouraging the industry which is vital ıe prosperity of the State. The appendix con- of Mr. Jennings's statement read before the s Commission at Johannesburg, May 12, 1897.

General Notes.

ɔAL FIELDS IN WESTPHALIA.—An account ese are given in a report to the Foreign Office from S. H. Gastrell, Commercial *Attaché* to H.M. ɔassy in Berlin. The discovery of a seam of coal depth of 464 metres has recently been made by Dortmunder Coal-boring Company in the neigh- hood of Nateln, in the district of Soest. It ars, therefore, that the beds of coal extend much ıer to the east from Dortmund than was formerly ɔosed. The seam discovered is reported to be of good quality, and it would appear that the coal of the Dortmund district are considerably more nsive than those hitherto worked.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Vednesday evenings, at 8 o'clock:—

EBRUARY 8.—"Nernst's Electric Lamp." By ES SWINBURNE. ALEXANDER SIEMENS, nst.C.E., will preside.

EBRUARY 15.—"The Balloon as an Instrument Scientific Research." By the Rev. JOHN M. ɔON, F.R.A.S.

FEBRUARY 22.—"Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

MARCH 1.—"Leadless Glazes." By WILTON P. RIX.

MARCH 8.—"Cornish Mines and Miners." By J. H. COLLINS, F.G.S.

MARCH 15.—"Liquid Fuel." By Sir MARCUS SAMUEL. Sir EDWYN S. DAWES, K.C.M.G., will preside.

MARCH 22.—"London's Water Supply." By WALTER HUNTER, M.Inst.C.E.

Dates to be hereafter announced:—

"Preservation of Timber." By S. B. BOULTON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 9.—"The Penal System at the Andamans." By Colonel RICHARD CARNAC TEMPLE, C.I.E., Chief Commissioner of the Andaman and Nicobar Islands. The EARL OF NORTHBROOK, G.C.S.I., D.C.L., F.R.S., will preside.

MARCH 9.—"Leprosy in India." By H. A. ACWORTH, C.I.E., late Government Municipal Commissioner for the City of Bombay.

APRIL 13.—"Judicial Reforms in Egypt in Relation to the Indian Legal System." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive.

MAY 11.—"The Port of Calcutta." By SIR CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

MAY 25.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

The meetings of February 9, and March 9 will be held at the Imperial Institute; those of April 13, May 11 and 25 at the Society of Arts.

FOREIGN AND COLONIAL SECTION.

FEBRUARY 28.—"Persian Trade Routes." By A. HOTZ.

MARCH 21.—"The Commercial Development of Germany." By C. ROZENRAAD, F.S.S., and Fellow Institute of Bankers.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

FEBRUARY 21.—"Vitreous Enamels." By CYRIL DAVENPORT. Sir OWEN ROBERTS, M.A., D.C.L., will preside.

MARCH 14.—"Craftsmanship and its Place in a National Scheme of Art Culture. By Sir WILLIAM BLAKE RICHMOND, K.C.B., R.A.

APRIL 18.—"Modern Changes in Taste relating to Domestic Furniture." By GEORGE LOCK.

MAY 2.—"Maiolica." By WILLIAM BURTON.

MAY 30.—"Wrought Iron Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

DR. SAMUEL RIDEAL, "Bacterial Purification of Sewage." Four Lectures.

LECTURE IV.—FEBRUARY 6.

Differentiation of the organisms—Scott Moncrieff's later process — Nitrification and nitrosification—Adeney's "oxygen system"—Conditions for aerobic and anaerobic change, and criteria for judging the purity of effluents—Resumé and suggestions.

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

February 20, 27, March 6, 13.

PROF. HENRY R. PROCTER, "Leather Manufacture." Four Lectures.

April 10, 17, 24, May 1.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Samuel Rideal, "Bacterial Purification of Sewage." (Lecture IV.)

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Inaugural address by the President, Mr. John Corry Fell.

Imperial Institute, South Kensington, 8½ p.m. The Hon. Thomas Mackenzie, "Explorations in Fiordland, New Zealand."

Surveyors, Savoy-street, W.C., 8 p.m. Adjourned discussion on the paper by Mr. William Weaver, "The London Building Act, 1894, and the Official Supervision of Buildings."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. A. H. Tiltman, "Public Baths and Washhouses."

Medical, 9, Conduit-street, W., 8 p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Dr. Kidd, "Protection among Animals."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. W. Handcock, "Everyday Applications of Electricity."

TUESDAY, FEB 7...Royal Institution, Albemarle-street. W., 3 p.m. Prof. E. Ray Lancaster, "The Morphology of the Molluxa." (Lecture IV.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. A. Jones, "The Waterworks of the Madras Presidency."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C. 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. F. E. Beddard, "The Cerebral Convolut[...] the Gorilla." 2. Dr. R. O. Cuuningham, '[...] on the Presence of Supernumerary Bones o[...] ing the place of Prefrontals in the Skull of [...] Mammals." 3. Mr. G. E. H. Barrett-Ha[...] "The Mice of St. Kilda." 4. Prof. W. Bl[...] Benham, "Notes on *Notornis*."

WEDNESDAY, FEB. 8...SOCIETY OF ARTS, John-[...] Adelphi, W.C., 8 p.m. Mr. James Swir[...] "Nernst's Electric Lamp."

Sanitary Institute, 74A, Margaret-street, W., [...] Mr. R. E. Middleton, "Supply of Water to I[...] by the Welsh Scheme."

Royal Literary Fund, 7, Adelphi-terrace, [...] 3 p.m.

Royal Society of Literature, 20, Hanover-[...] W., 1 p.m.

THURSDAY, FEB. 9...SOCIETY OF ARTS, 4½ p.m. ([...] Section). Colonel Richard Carnac Temple [...] Penal System at the Andamans."

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., [...] Prof. E. Arber, "Stories from the *Spe*[...] 1711-1712."

Royal Institution, Albemarle-street, W., [...] Dr. A. Macfadyen, "Toxins and Anti-T[...] (Lecture I.)

Electrical Engineers, 25, Great George-street, [...] 8½ p.m. 1. Mr. J. Pigg, "Rules for the R[...] tion of the Wiring of Premises for Connec[...] Public Supply Mains." 2. Mr. C. H. Word[...] "The Regulation of Wiring Rules." 3. Mr [...] Compton, "The Institution Wiring Rules [...] Mr. Miles Walker, "Electric Traction by S[...] Contacts."

Mechanical Engineers, Storey's-gate, Westm[...] S.W., 7½ p.m. Annual General Meeting. [...] William C. Roberts-Austen, "Fifth Report [...] Alloys Research Committee: Steel." [...] William Powrie, "Machinery for Bool[...] General Printing." 3. Mr. Harry G. V. Ol[...] "Evaporative Condensers."

Mathematical, 22, Albemarle-street, W., 8 p.[...]

FRIDAY, FEB. 10 ... Mechanical Engineers, Storey'[...] Westminster, S.W., 7½ p.m. Reading of [...] and Discussion.

Royal Institution, Abemarle-street, W., [...] Weekly Meeting. 9 p.m. Prof. H. S. [...] Shaw, "The Motion of a Perfect Liquid."

Civil Engineers, 25, Great George-street, S[...] p.m. Mr. William Middleton, "The El[...] Driving of Engineering Workshops."

Astronomical, Burlington-house, W., 3 p.m. [...] Meeting.

Junior Engineering, Westminster Palace [...] S.W., 7½ p.m. Joint Meeting with the Dis[...] Section of the Architectural Association [...] J. H. Pearson, "Factory Design."

Philological, University College, W.C., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burli[...] house, W., 5 p.m. Annual General Meeti[...] Address by the President. 2. Mr. Be[...] Davies, "An Ampere-Meter and a Volt[...] with a long scale." (This will probably b[...] by Dr. Lodge.)

SATURDAY, FEB. 11...Education Department, South K[...] ton Museum, S.W., 3½ p.m. Mr. J. H. [...] "Furniture."

Botanic, Inner Circle, Regent's-park, N.W., [...]

Royal Institution, Albemarle-street, W., [...] Lord Rayleigh, "The Mechanical Proper[...] Bodies." (Lecture I.)

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FRIDAY, FEBRUARY 10, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ADJOURNED ORDINARY MEETING.

The discussion on Mr. Dixon H. Davies' paper on "The Cost of Municipal Enterprise," read on Wednesday, February 1st, was resumed on Thursday, the 9th, Sir Westby B. Perceval, K.C.M.G., in the chair.

The report of the discussion will be printed in the next number of the *Journal*.

CANTOR LECTURES.

Dr. Samuel Rideal delivered the fourth and last lecture of his course on "Bacterial Purification of Sewage," on Monday evening, 6th inst.

On the motion of the Chairman, a vote of thanks to the lecturer was passed.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, February 9, 1899 (at the Imperial Institute); the Right Hon. the Earl of Northbrook, G.C.S.I., D.C.L., F.R.S., in the chair.

The paper read was "The Penal System at the Andamans," by Colonel Richard Carnac Temple, C.I.E., Chief Commissioner of the Andaman and Nicobar Islands.

The paper and report of the discussion will be printed in a future number of the *Journal*.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday evening, January 31st, 1899; Major-General Sir John F. D. Donnelly, K.C.B., Vice-President of the Society, in the chair.

The paper read was—

THE SENEFELDER CENTENARY EXHIBITION OF LITHOGRAPHS, 1898-99.

By Edward F. Strange.

The circumstances which led to the organization of this exhibition are pretty well known; but for the sake of the record it may be advisable to shortly recapitulate them.

It had been clearly shown that the year 1798 was that to which the invention should properly be ascribed, inasmuch as it saw the discovery of what Senefelder himself called "chemical printing," the essential principle of lithography. An early representation to this effect was made by Mr. Joseph Pennell, who pointed out to the Society of Arts the importance of the opportunity and the advantages that might accrue to the art by a formal celebration and exhibition of work. The Society, from the years 1818 and 1819, when medals were awarded to Senefelder and Hullmandel, one for his invention, the other for skill in the use of it, has taken a keen and practical interest in the subject. Its *Journals* contain many important communications, and from time to time papers have been read before it and awards made for various improvements. The proposal was therefore welcomed, and a committee formed to carry it out; but after several meetings and the most careful consideration, it was decided to seek for some means of making the exhibition more comprehensive than was possible with the immediate facilities at the Society's disposal. Ultimately it was suggested that the Department of Science and Art should carry out the scheme and hold a loan exhibition in the South Kensington Museum. This proposal was accepted by the Department in July last, a committee including the whole of that formed by the Society, with some few additions, was called together, and the exhibition opened to the public on the 21st November, 1898. It will remain open till the 28th February next.

The total number of exhibits exceeds 2,200, and on the whole the collection is very representative of the artistic and historical sides of the art; but it was not possible at so short a

notice to provide space for the important technical and industrial interests involved. These might well prove a subject for a future exhibition, if it should be found possible to hold one.

On the present occasion I do not propose to enter into any systematic examination of the history of lithography. But the exhibition has afforded a means of making comparisons between the varying fortunes of the art; and perhaps of arriving at an estimate of the characteristics of successive phases, with more accuracy than has hitherto been possible. To this end I shall direct my endeavours in the hope that the suggestions I have to place before you may be found worth consideration, discussion, and, if necessary, refutation.

There still exists, if the published criticisms on the exhibition may be trusted, a considerable amount of ignorance as to the so-called "Polyautography," a collection of which prints occupies the earliest place at the beginning of the British Section. Within the last few days the prints have been said to "appear to have been produced from drawings made on paper, whilst Senefelder drew directly on the stone." (As we know, one of the first things Senefelder invented was a transfer paper.) The writer goes on to remark, sagely enough, "But it is worth noting they were all by the pen, and consequently we may suppose chalk or coloured drawings were beyond the power of polyautography, which apparently resembled some of the processes still employed in offices for manifold copies." Now a conclusion of this sort really seems to call for a precise statement of the circumstances, as far as they are known, under which this special and easily recognisable class of lithographs came to be produced.

Senefelder came to London in 1800. He stayed with his agent, Philip André, who, says he, "kept me in a perfect seclusion from society, for fear of losing the secret, for seven months, before even the first step towards obtaining our object, was taken." He did succeed in getting his patent, No. 2518, dated the 20th June, 1801, and returned to Germany, having "sufficiently instructed" André. "I also," says he, "made some progress in the aqua-tinta manner, in which Mr. Gessner . . . an artist of talent, drew some pleasing landscapes." (These, by the way, I have not been able to trace.) "I am convinced," he proceeds, "that the public would have a greater number of masterly productions of the new art before them, if it had been my fortune to fall in with an enterprising printseller, wh[o] employed proper artists, and undertook in[teresting] works."

It seems very much as if, for purposes of h[is] own, André had misled Senefelder, for one ca[n] with difficulty otherwise explain this complain[t] in the face of the fact that on the 30th Apri[l] 1803, André published "Specimens of Poly[autography], consisting of Impressions take[n] from original Drawings made purposely f[or] this work." André heads his title, "By Hi[s] Majesty's Royal Letters Patent," and style[s] himself "Patentee." But as a fact he neve[r] took out a patent for any process whatever and his "specimens" are ordinary lithograph[s] in the "pen manner." Senefelder was clearl[y] under the impression when he wrote his boo[k] in 1817-18 that he had not had a fair chanc[e] at the hands of British artists. But André'[s] prints are by Stothard, West, Barry, Fuseli Sir R. K. Porter, R. Corbould, T. Hearne W. Delamotte, T. Barker, and R. Cooper, and surely no more representative set of artists could have been got together at the time The earliest of these is by West, and is dated 1801. He evidently gave the process a fair trial, for in 1802 he produced another in the chalk manner. From this date until 1811 a constant succession of dated prints has been found of similar character Afterwards, only a few, until 1816, the period of the last in the style. Most of these are in the so-called "pen-manner," or, in imitation of engravings, etchings, or woodcuts, but in the exhibition will be found, in addition to the print by West, already mentioned, Nos. 1[3] and 14, by H. B. Chalon (1804), No. 35, by Fuseli, and No. 46, by Varley (1811), all in the chalk manner; while several are entitled "printed from stone," and No. 28, "printed from a pen and ink drawing on stone"—evidence as to their nature which is too explicit to leave room for any doubt. There are also numerous references to the "Polyautographic Office," and Volwieler printed the illustrations to the Frescoes of the Chapel of the Holy Trinity, Stratford-on-Avon, before April, 1807, in precisely the same manner—"from stone, at the Polyautographic Press."

The preface to Francis Moser's specimen book (1819) sufficiently explains the failure of polyautography, and, at the same time, identifies it beyond a doubt with lithography. It also confirms our impression as to André's treatment of Senefelder, whose very name Moser does not mention. He says: "The unfavourable opinion of lithography, which

now prevails, may be traced to the circumstances under which it was introduced into their country. When Mr. André came to England in 1803, many of the first artists in the kingdom practised lithography, but as the art of printing from stone was not then brought to perfection, the impressions obtained were few in number, and not good." Also, lower down: "Drawings may be made with ink or chalk. The latter is the best for use, but the more difficult to print." The specimens in the book are by Hullmandel, Blore, H. Corbould, and G. Scharf, sen.

After Senefelder, it is most certainly to Charles Joseph Hullmandel that we must give credit for the propagation of lithography in this country. It was he who in 1819 gained the Silver Medal of the Society of Arts for the "Best specimens of lithography executed on German stone," the work submitted including specimens of the various styles, and especially of the "imitations of acqua tinta." This latter method he afterwards developed into what he called lithotint—a process used with such fine effect by Prout, Hulme, Cattermole and Taylor. The patent (No. 8683), for this is dated 5th November, 1840, and the title describes it as a "new effect of light and shadow, imitating a brush or stump drawing, or both combined, being an impression on paper from a prepared paper or stone, preparing the said plate or stone."

It is, I think, one of the sad conclusions forced on a visitor to the exhibition, that this beautiful process should have been allowed to die. With the exception of a single print, by Mr. Frank Short, which is more nearly akin to mezzotint, I am not aware of any modern attempt at anything of the kind. It would be claiming too much to set it on a level with mezzotint at its best; but surely the examples shown display effects and capabilities worthy of any artist's attention. The technique does not seem to have been too laborious—it certainly cannot be compared in this respect with that of mezzotint—and it seems not unreasonable to expect that for certain classes of subjects it should prove to be absolutely the right tool to use. A well-known lithographer told me recently that he did not know of a single man who was now practising lithotint. Perhaps the advantages of distinguished isolation may induce someone to take it up.

In looking at the exhibition as a whole, one is bound to remark the curious manner in which the exhibits classify themselves. With the polyautographic prints we have already dealt, and I shall only supplement my earlier remarks by now pointing out that the device of enlisting the services of prominent artists in order to popularise lithography has been tried in this country on no less than three occasions, and that each time the results of their experiments are very nearly all that we could find to represent the nation during each specific period. The polyautographic prints form the first of these series. The second is due to the exertions of Mr. T. Way, who in 1871 induced E. J. Gregory, R.A., R. Thornwaite, F. R. Stocks, J. Parker, A. Morgan, Sir J. D. Linton, Joseph Knight, J. W. Buxton Knight, E. Hayes, Charles Green, and J. W. Chapman to try the merits of drawing on stone. The results form the set published as "Hogarth Sketches;" but I think I am right in saying that the movement was not followed up. It is to a demonstration by Mr. T. R. Way, at the Art Workers' Guild in 1893, that is due the next effort to awaken interest in lithography. On this occasion transfer paper and chalk were served out to several of the members, and a practical proof given of the ease with which a print could be produced by this means. Consequently, on the approach of the Paris Exhibition of 1896, when it was found that unless something heroic was done, this country would be represented by only two or three names in the catalogue, Messrs. T. R. Way and Goulding again approached a number of prominent artists, and so secured a reasonable set of studies under circumstances of great difficulty. The work produced on this occasion was in many instances of such merit, and had the added advantage of being so easy for the artist, that many were induced to continue its practice both on the stone and on paper with results that are perhaps too recent for criticism. At all events the revival in the eyes of the public became an accomplished fact: though it must not be forgotten that lithography has never been dead to the same extent as engraving on wood, and even more, on steel. It has been, and is, continually practised by hundreds of draughtsmen, thoroughly skilled in its technique, but whose business in life is to do work for various industries rather than for art galleries or illustrated books. It is hardly likely that so large a body of craftsmen should not contain some artistic talent; and it is a matter for regret, that although the exhibition was widely announced both in the trade periodicals and all the other journals of importance, very few works were contributed to us from this source.

But to go back to the question of grouping. The first case is the set of lithographs executed for Baron Taylor's "Voyages Pittoresques." The early volumes are illustrated by Baron Atthalin, Fragonard, Isabey, Horace Vernet, Villeneuve, and others; but very early in the series will be found examples of the work of Bonington, Prout, Louis Haghe, Boys, and G. Barnard. We may claim that these stand out clearly from the work of their French collaborators; but this may, none the less, have been due to the influence of the latter. And by way of Harding, Lane, Nash, and their school, it reacted on British lithography. However this may be, we have for our next group the productions of the famous circle of artists gathered together by Baron Taylor for his monumental work. Time is too short to do more than specify some of the other groups. In England, we had the drawing-master type, perfect in technique from the mechanical point of view, but with little originality; and, later on, the group of portrait lithographers, Baugniet, Lynch, Maguire, Fairland, and Messrs. J. A. Vinter and J. R. Dicksee, who are still with us. Taylor, Cattermole, and Hulme I have already dealt with. Louis Haghe and Nash are each at the head of small schools of disciples, and again their merits lie rather in the excellent reproduction of a drawing, or true representation of an object, than in any exercise of imagination or design. In fact, this must be looked on as the prevailing characteristic of British lithography—and I am inclined to think that the influence of Baron Taylor's work was not too remotely responsible for it.

But in France the sharp changes of political fortune and general unrest of the nation have produced very different results. There is nothing in the history of the art to compare with the battle pieces and military episodes of Raffet and Horace Vernet, with the satires of Daumier and Vernier, the early artists of *Charivari*, with the often grotesque force of Delacroix, and the keen and pathetic characterization of Gavarni. Géricault, whose album was published in London in 1821, has occasionally received the credit of having inspired the outburst of lithographic work in this country which undoubtedly marked the years succeeding that date. But it will be difficult to trace his influence in contemporary British work. Isabey stands alone as a master of original landscape work, both in his surpassing technique and the beauty of the subjects selected by him.

Then comes another great group of workers: those associated with the publication, *L'Artiste*. Much of their work is limited to the reproduction of pictures; and they developed a close, highly-finished method which is not without a charm of its own, but cannot for a moment stand by the side of the great original painter-lithographers just mentioned.

In Holland we have the series of lithographs produced since 1840, for the *Kunst Kroniek*, on much the same lines, though I fancy it is hardly so well known. The work is not so good on the whole as that of the French series; though some of the plates issued in the Sixties have a distinct value.

Germany, the home of the art, has proved singularly barren, so far as its earlier lithographs are concerned. The reproductions of pictures in the great galleries, which engaged so many French and Spanish artists, were, perhaps, by none so well executed as by Piloty and Strixner, who were closely associated with Senefelder himself. It is perhaps a pity that the only work of the inventor in the exhibition should have been the specimen-plates of his book, but a loan exhibition cannot command the public, and no examples were offered.

It will, I hope, have been seen then, that while on the Continent lithography had the support or stimulus of a series of great undertakings or movements of national feeling, it never received any such in England. Lane was indeed an Associate of the Royal Academy, and Her Majesty the Queen, who is deeply interested in the art, has always supported it by the institution at court of the post of Lithographer in Ordinary, so long and honourably held by Mr. J. A. Vinter. The men, who in the Sixties might have made a brave show with their own work instead of relying on the transcription of the wood engraver, seem not to have tried it even in the least degree; and whatever reputation may be gained by British Lithography—I speak for the present, of the original work of artists only, and not of the excellence of British workmanship on the indnstrial side—lies in the hands of the artists of my own generation. Happily there are those who already give notable promise and have even already achieved much.

But the questions still remain to be answered. Is artistic lithography alive again, what has it got to show, and what is it going to do? Well, more or less in this country there are perhaps half-a-dozen British and two American artists, Messrs. Shannon,

R. Way, Rothenstein, C. J. Watson, ang, McCulloch, Oliver Hall, Whistler and nnell, who practise the art in the proper ıse of the word. And there are perhaps or 40 other artists who have tried their nds at it to the extent of from one to five six prints. And that is all. But when get across the Channel in France, Holland, rmany, we can number the new lithographers the score. Fantin-Latour, whose splendid ries is one of the remarkable features of the hibition, and Menzel, who is by no means equately represented, I do not include. But illette, Carrière, Cheret, Blanche, Charpentier, vière, Dillon, Ten Cate, Havermann, Van oytema, Greiner, Burger, Orlik, Daur, hnopf, Hans Thoma, Kampmann, Langhein to name only a few—are all hard at work. nd they are not content with the mere chalk etch, or even the more highly-finished draw- g. Most of them are using colour, not, as was finely done here in the early history of iromo-lithography in the reproduction of oil water-colour pictures, but as an integral part the design from the beginning. It is early yet count results. With the exception of Whistler's ell-known experiments, I believe the device is never been tried before. And the speci- ens so far seen are calculated to provoke the ost varied criticism. But in some instances, I ink it must be conceded that the result is a chnical success; and that even the maddest weakest productions may serve to show that iere is a future for lithography in colour. But must stand on its own merits, with all its mitations and advantages. The most fatal uality in lithography is the facility it affords r imitating any other process of illustration on ie face of the earth. And yet it is capable f individuality. The works of Daumier and Gavarni, of Raffet, Menzel, and Isabey have roved that in the matter of black and white. t will have to be the same in colour. If the mits imposed by the use of a few tints only e frankly accepted, and the convention of the icture adjusted to them, whether the result be decorative panel like those of Rivière or an lmost realistic landscape like the "Winter" of Baum, its success will depend on the artist. The process is competent enough. I see no eason why the colour-print produced in this nanner should not achieve the fine results of he wood-cuts of Japan; and be as widely opular here as those beautiful prints were in heir own country. It does not follow that the ubjects need be restricted to the acute sym- olism of one school, or the slavish adherence of another to alleged decoration. If British —and American—artists would give us just their own ideas with the added charm of colour, I think they would find us appreciative. I am not skilled enough in the technique of colour lithography to know how far it is possible for transfer-paper to be used in the production of such prints as we are getting from Karlsruhe and Munich. I do know that several of the artists at the former place are working litho- graphers in every sense of the word, and that part of their employment is on what is rather invidiously known as commercial work. But even if the paper be impossible, it seems as if salvation might be found in the aluminium plate. The colour-work of Thoma certainly indicates great possibilities.

Within my limited space I have had neces- sarily to confine myself to a few phases only of the art. Its application to industrial purposes is an enormous and most interesting question, including as it does not only that of the com- petition of the photo processes, but also the assistance afforded by them to the further development and extended use of the litho- graphic stone. I have been compelled, as I say, to speak of lithography as if the artistic side of it was the only one; but institutions whose scope and interests are as wide as those of both the Society of Arts and the Department to which I belong could not confine themselves to so rigid if attractive a boundary, and I hope that the technical and industrial portions of the subject may shortly engage the attention of both bodies. As to artistic lithography, the artists have its future in their own hands. Perhaps I may be forgiven if I suggest that more of them should invest a little enterprise in a process which should by no means be always identified with inferior or common- place productions.

The paper was illustrated by a series of lantern slides of historical lithographs chosen from the Exhibition and from the Print Room of the British Museum. There were also shown on the walls some framed foreign lithographs from the Exhibition, lent by the Science and Art Department, and some modern German lithographs lent by Mr. Charles Holme.

DISCUSSION.

Mr. F. GOULDING said the exhibition at South Kensington had been very instructive to many, and if the authorities would follow it up by an exhibition

of black and white art generally or of engraving, it would be still more beneficial.

Mr. CRANE said he remembered some fifty years ago his father having a set of Cruickshank's Bottle Series, which were certainly lithographs, but he did not think a set could be got now.

Mr. JOHN LEIGHTON said he had a set of Cruickshank's "Bottle," but they were done by Palmer's process, a method for producing a relief printing surface from an engraved or etched plate, though an ordinary observer would take the result for a lithograph. It was very remarkable what good effects of light and shade could be produced in lithography, even by an unpractised artist who knew nothing of the technique. There were two methods of working—ink and "chalk," though the latter was not chalk at all, but a mixture of grease and some powder, whilst the ink was rubbed up on a palette with water; and also two sorts of surface employed—the smooth stone and the grained. Lithography was the only mode of printing in which a scraper was employed, the surface being perfectly flat, not raised as in letterpress, or sunk as in etching and engraving. Fifty years ago in that room he made a drawing on stone to illustrate a lecture given by Mr. Blair Leighton. One great point about it was the weight of the stone, which had led to the use of zinc plates, and much which was called lithography was really zincography. Another difficulty from a commercial point of view was that copies could not be produced at a high rate of speed, as they required careful printing. One very fine series of prints which had not been mentioned was the Dresden Gallery, which were all lithographs. He did not think that a drawing on transfer paper—though it had the advantage of being as a print would appear—ever equal to one direct on the stone, though some very bold effects could be obtained. On the stone, one could get a finer touch, and by working with ink and chalk together, could obtain a double power.

Mr. J. PENNELL said Mr. Strange had not yet been thanked for the great work he had done at South Kensington in hanging and cataloguing, for though a committee was appointed, of which he had the honour to be a member, Mr. Strange practically took all the work out of their hands and the whole success of the exhibition was due to him. Having seen all the large exhibitions, including Paris and Düsseldorf, he could say that this one at South Kensington was much more complete. Like Mr. Strange he had never seen an actual lithograph of Cruickshank's, but it was well known that many of his engraved plates, as those of Leech and Seymour, were put upon stone and printed and sold as etchings. Mr. Strange had shown up to some extent the intelligence of the professed art critic, but had not referred to the most remarkable instance. It had been stated again and again in the Press that lithograph was of no artistic value, nor worth t attention of a collector, because it could be pr duced by the million in absolute *facsimile.* O would think that if you could get an absolute *fa simile* of an artist's work it would be a good thin but in lithography you got the artist's handiwo multiplied. With regard to the unlimited number whi could be printed, those who knew anything about t subject were well aware that the finer the drawing t fewer proofs could you get which were at all like There was an enormous loss in effect if the drawi on the stone was elaborate, and a large number cou not be printed. The most wonderful art magazi ever published, *L'Artiste*, had ceased to publish lith graphs because they could not print enough copi from stone to supply the subscribers. On the oth hand, it was said that you could not get as ma proofs from a stone as from a copper-plate; but S Seymour Haden had said over and over again th with steel facing, as now practised, one should nev take a proof from a copper-plate at all. If you stee faced a copper-plate you could pull an enormo number of prints, because you could re-steel it it began to show signs of wear. In wood-engra ing it was pointed out by Papillon that 250,0 impressions could be taken, and he had been i formed by the printers of *Punch* that so long they used wood engravings they printed from t original blocks and never thought of taking electr or stereos. But in lithography no more proofs coul be printed than from etchings, and the original ston could not be protected. It, therefore, appeared th lithography would give a fewer number of impressio from the original than anything else. He did n say what might be done in future—he was simp referring to the past. Mr. Strange said no one hard was using lithotint, and, unfortunately, there we but few, but Mr. Whistler had done a great numbe He had tried it himself, but found it extremely dif cult, and made an awful mess of it. As to printi from paper in colour, he believed all Lunois' work, an he had made many lithotints, was done from pape and he considered that as elaborate work could b done from paper as from stone, owing to the perfecti to which paper and presses had been brought. H thought, in justice to Mr. Goulding, more credit shou be given him, and to Mr. Alfred Gilbert, the sculpt for the English Section in the Paris Exhibition. H rather objected to calling lithography a process Senefelder invented everything except photo-lith graphy, and he did not speak of different processe but of different manners. Process, to his min implied photo-engraving or something of that kind.

Mr. J. S. MORRISS said they were all indebted t Mr. Strange for getting together such a magnifice collection. He was interested, not so much from a artistic as from a trade point of view. Lithograph was not a process; it was one of two things: it wa either an art, the work of an artist who put his desig

1 the stone; or, from his point of view, it as a craft, the skilful reproduction of the design ut upon the stone by the artist. With regard the number of copies obtainable from the graphic plate, he could say that they had re-roduced 193,500 copies, and the plate was in good a condition as when they started. One ason why lithography was not more practised in is country was that artists, as a rule, worked at ome, and it was not an easy thing to carry stones eighing half a ton, such as would be required for decent-sized picture, backwards and forwards, and it had to be printed in seven or eight colours, the eight would be two or three tons; there would be risk also of a stone being broken after a design had een put upon it. This difficulty had been overcome ecently by the use of algraphic plates, which eighed very little more than a sheet of millboard of he same size, and could be carried about or sent by ost, and the artist could turn it about when working t it, to suit his convenience. This also met the ther objection about the artist's work being lost when ransferred to the stone. If the artist drew directly n the plate, every point and every line of such rawing was reproduced, and that he considered he acme of artistic perfection. For over eighteen ears he had been connected with lithography, nd he had never known a transfer go on to a tone or plate or any other material exactly as it ad been put on the paper. The loss might be nfinitesimal, but there was a loss. If one were rinting a very fine work from the stone, by the time ix or seven thousand copies had been taken, the lines egan to thicken; if one used a zinc plate, the lines vould be gone. Consequently, lithography did not ive a true reproduction of the artist's original except or the first few copies.

Mr. MORGAN said they knew that for many ears lithotint fell into disuetude, after the death of Hullmandel, but it was revived by Mr. Way during he early seventies, and Mr. Whistler made several of is finest drawings in that medium; one called "A Nocturne," another "Limehouse," and "A View from the Savoy Hotel," were shown there ome months ago when Mr. Pennell read a paper on 'Lithography." Mr. T. R. Way also made an xcellent drawing in lithotint, entitled "Seagulls;" nd anyone looking at those specimens would say hey were equal to any produced by Hullmandel. It was said by some that drawings done on transfer aper were not equal to those done on stone, but if nyone would compare Mr. Whistler's drawings of St. Giles' Church and The Manager's Room, he would defy him to say which was done on paper and which on stone. Mr. Morriss had ridiculed the idea of taking a large number of copies from a stone, but hree months ago he had printed 80,000, and the last copies were quite equal to the first. At the same ime, when you were speaking of fine-art production, t was quite true that only a small number could be obtained; he should not think of undertaking to print 80,000 copies of a fine art work. He thought some of the work done by Shannon, Rothenstein, Pennell, Whistler, and others, was quite equal to anything produced in the palmy days of lithography.

Mr. P. B. WATT was rather surprised at the diversity of opinion as to the number of copies which could be produced, and asked if the 80,000 were all printed from one stone.

Mr. MORGAN said they were.

Mr. WATT said he had had many years practical experience of lithography, and never knew of such a thing being done. He desired to thank Mr. Strange and Sir John Donnelly for the honour they had done lithography in holding this exhibition at South Kensington. If the art had been lost, as some said, they were certainly recovering it again, but it was just as well not to take an exaggerated view, and when they spoke of fine art productions, it would be better to speak of two or three hundred, or two or three thousand copies, instead of the large numbers they had heard of. Although England was the first to take up Senefelder's invention, she was now far behind other countries, especially France. It was not a question of technique, it really turned on the artists who were engaged. If we were to recover our position we must train artists and show that this art was thoroughly suitable for book illustration. He was sorry Mr. Strange had not said more about the invention of grained paper, which though suggested by Senefelder himself had been much improved and brought to perfection by Nelson, of Edinburgh. Few English artists practised lithography, mostly preferring to scratch on a piece of copper, which they called etching, but there was not a finer art than lithography if they would only take it up. At South Kensington the whole history of the art from the beginning was shown; and one could not but regret the decadence that had taken place, for he could not agree that the modern men were equal to Bonington, Lane, Cattermole, and others. He hoped that any artists who were inclined to practice this art would try what could be done with grained paper.

The CHAIRMAN said it was his duty as chairman to propose a vote of thanks to Mr. Strange, but the words had been taken out of his mouth by previous speakers. He could not pretend to any practical knowledge of lithography, though he did once something which he was told was chalk—though he now heard that it was not—on a piece of stone, and the printer afterwards brought him proofs of it, but he was glad to say that no copies had been preserved. They owed a great deal to Mr. Strange for the trouble he had taken in getting up this exhibition; and he was very glad that the work of the Department in organising it at the suggestion of the Society of Arts had been so highly appreciated, and hoped it might assist to some

extent in the revival of lithography. It had never died, but latterly had not been very much appreciated, and that, probably, was one of the reasons so few artists had practised it. The effect of the exhibition could be seen already, by the number of old coloured lithographs now exhibited in shop windows, which two months ago had nothing of the kind. A great deal had been said about the reproduction of lithographs, but he thought that some confusion was caused by the use of the word reproduction in this connection, it was rather multiplication. Reproduction was where one was making a lithograph from a picture or a drawing, but it was a question of multiplication when one spoke of the number of copies which could safely be taken from a stone. The advantage or disadvantage of such multiplication might be looked at in different ways. One gentleman seemed to think it was a disadvantage, whilst others thought it a great recommendation. From the consumer's point of view, the power of taking large numbers was a benefit, but for the producer it was probably better that there should be only a few choice prints of higher value, as in the case of etchings when there was no "steeling" of plates. His own feeling was in favour of stone lasting as long as possible. No one had gone very fully into the question of why lithography had fallen in the public estimation within the last 20 or 30 years, but to some extent he thought it was due to the fact that lithography, especially of the commercial kind, had been applied to a kind of work for which it was not properly adapted, until at last the word "chromo" became a term of reproach. It was always said that when you became mechanical you destroyed all art, and that was no doubt true to a large extent, but it must strike everyone that there were some exceptions. For instance, when printing superseded manuscript, nothing could be more mechanical than printing, yet they knew that the printed page, as it had been printed by some of the great men who produced the first fonts of type, was really as fine a work of art (and was valued as such), almost, as many of the MSS. That arose from the fact that the early printers did not slavishly copy the handwriting of the missals and fine books, but formed a letter which was adapted to its purpose—that of being used mechanically. In the same way he would suggest that chromo-lithography fell into disrepute, because instead of using lithography for purposes for which it was intended, it was employed to imitate water-colours, which were not adapted for reproduction in that way.

The vote of thanks having been carried unanimously,

Mr. Strange, in reply, said the reference to the lithographs attributed to Cruickshank reminded him of one of the most interesting experiences he had, and that was the weeding out of a number of soft ground etchings and wood-cuts, which were sent in to be exhibited as lithographs. It had been remarked that the quality of a lithograph was partl dependent on its being printed from a perfectly fla surface; that was so, as generally practised; but th old system survived for a long while in the Lo Countries and in France, and in Senefelder's own boo there were specimens which he variously described a etched stone and engraved stone. In some cases th relief of these was so high, that you could hardly tell i from an engraving by passing your finger over it. H was glad to hear that there were some few specimens c modern litho tint which he had overlooked, though i still did not appear that the art was being practised His mission was rather to bring the matter before th public, and let them deal with it, and he would no attempt any apology for the many omissions in th paper. He was simply the agent to collect material fron one branch of the public, and pass it on to those other interested, who were sufficiently educated to appre ciate it. He was sorry if he had given the impressio that the work of Mr. Goulding in connection with th 1896 Exhibition was not sufficiently noticed; but h feared Mr. Goulding had himself to thank if it were so he was so completely identified with black and whit work that his enthusiasm was taken for granted. A objection was taken to the word "process" becaus it had become identified with the very modern art c photo-reproduction. The public had a right to us their own language, and if they preferred to let thi modern meaning of the word supersede its ol meaning, that was their affair. He must sa that he had been very fortunate in this matter It was very rare, according to his experience, tha a servant of the Crown coming into persona contact with an outside body of interested workers should receive such strong and cordial support. H had been simply the agent, and it would have bee utterly impossible for the work to have been carrie out to the public satisfaction if he had not had th co-operation, which probably he only could full appreciate, of his colleagues in the Science and Ar Department. In so large an institution it wa absolutely necessary that the work should be sub divided, and it was very seldom that any portion of th work of a Government office could be identified wit any individual. In accepting the vote of thanks therefore, he wished to make it quite clear that h did so on behalf of his colleagues; he should tak care that it was conveyed to them, for it would be valuable encouragement to them in their work which, although interesting in itself, was sometime more thankless than generally supposed.

NINTH ORDINARY MEETING.

Wednesday, Feb. 8, 1899; Alexande Siemens, Member of the Council, in the chair

The following candidates were proposed fo election as members of the Society :—

[?]yans, Herbert William, 38, Chester-terrace, Regent's-park, N.W.
[?]tlin, William Henry, B.A., Irthlingborough Iron Works, Wellingborough.
[?]mpion, Alfred, Blochairn Steel Works, Glasgow.
[?]ucar, Alexander Louis, Hauteville, St. Germans-place, Blackheath, S.E.
[?]ffcken, Arthur W., Wyandotte, Shirley, Southampton.
[?]uedalla, Florance Montefiore, 33, Addison-road, W.
[?]ingham, R. T., 6, Finsbury-square, E.C.
[?]orris, Major Stephen L., R.E., 6, Wemyss-place, Edinburgh.

The following candidates were balloted for [a]nd duly elected members of the Society:—

[?]unyard, George, Kenmore, Maidstone.
[?]apel, G. W., Montana, Park-lane, Croydon.
[?]ollis, John William, 55, Glenwood-road, Catford, S.E.
[C]olman, Russell J., Carrow Works, Norwich.
[E]vans, Peter MacIntyre, M.A., Clothworkers' Hall, Mincing-lane, E.C.
[F]lint, Stanley, 12, Museum-chambers, Bury-street, W.C.
[G]ray, Frank James, 9, Upper King-street, Norwich.
[H]unter, Walter, 17, Victoria-street, S.W.
[R]amsay, James, Listoke, St. Stephen's-road, Ealing, W.
[R]anger, Charles Peter, Easthoathly, Sussex.
[W]ilson, John, Leadenhall-house, 101, Leadenhall-street, E.C.

The paper read was—

NERNST'S ELECTRIC LIGHT.

By James Swinburne.

Before describing Nernst's invention, it may be profitable to spend a few minutes reviewing the position of electric lighting. The whole industry is at present controlled by the incandescent lamp. We are so accustomed to this, and it is taken for granted in such an unconscious way, that we do not realise how much everything depends on the maker of the carbon incandescent lamp.

In very early days, that is to say, in the early eighties, there were a few Edison lamps at 100 volts, with an efficiency too horrible to mention, but the Swan lamp came along made for 50 volts. I say made for 50 volts ad-advisedly; I mean that the makers tried to make 50 volt lamps, and produced lamps taking from 40 to 60 volts. If the lamps were not bright enough you ran the engine faster, or put a smaller pulley on the dynamo. (The belt then generally slipped, but that is not to the point.) For about four years, which is a long period in the development of such a rapidly growing industry as electrical engineering, the makers of incandescent lamps, or in fact the makers of the Swan lamp, decreed that the electro-motive force used should be from 40 to 60 volts. There was no appeal. There was no development of central station supply at that time, but still, even then in large buildings there was the longing for higher pressures on account of the cost of the mains.

About 1885, the Swan 100 volt lamp came into use. It was a clumsy affair, with little loops of platinum at the sides. At first the lamps were pretty bad, but they gradually improved; and 100 volts, or in some cases 110 volts, became the recognised pressure for electrical supply.

As town lighting from central stations came into being, the limit of 100 volts became a serious trouble, and the evil was partly mitigated by the use of three or even five wire systems. I must point out that the incandescent lamp exercises its tyranny in two ways. It not only insists on a low pressure, such as say 100: and thus demands large leads to feed it, but it is so sensitive to variations of pressure that the system of distribution has to be arranged to give a practically uniform pressure at the terminal of the lamp. The necessity for uniform pressure probably gives more trouble, and costs more than the mere low pressure; and it would be cheaper to supply at 100 volts with a good margin of permissible variation of pressure than supply at 200, with a very small per-centage of variation.

Quite lately the incandescent lamp makers have produced things called 200-volt lamps, and some make them for 250 volts. So there is a general tendency on the part of supply companies to jump to a 200 volt supply. The innocent consumer is therefore pressed by the company to change over to 200 volts. The company likes the change very much, and the lamp maker also enjoys it, as he makes more lamps and charges more for them.

Considering the enormous importance of the incandescent lamp, its improvement has received extraordinarily little attention. It limits us as regards pressure, it used to hamper us by its cost, it limits us as to variation of pressure, and it limits us very seriously by its inefficiency. Yet, in spite of these, the carbon incandescent lamp has made practically no advance in 15 years. Of course mere detail improvement in manufacture has taken place, and this has led to better quality and greater uniformity, hence cheapness; but

there has been no radical improvement. The jump to 200 volts from 100, or from 50 to 100, did not depend on any sort of radical improvement in the incandescent lamp; it was merely the result of detail improvements, making it possible to produce long thin filaments. Other things being equal, it is easy to see that the long thin filaments must be weaker. If the carbon has the same specific resistance, the relation between pressure and length is $E = L^{\frac{3}{2}}$, and $E. = D^{-\frac{3}{2}}$. If the filaments are flashed, the proportions will be still more extreme. The question of high pressure incandescent lamps is thus — How far can we make the filaments longer and thinner and flimsier without exasperating our consumers? Unfortunately the consumer is rapidly getting saddened as it is. The 100-volt 8 c.p. lamp does not please him much, and the 200-volt 8 c.p. lamp has in no way delighted him; if the lamp is made with two 100-volt filaments in series, it combines the disadvantages of both, without the advantages of the small candle-power of either. But it adds some further disadvantages peculiar to the higher pressure which I have not so far touched upon, and that is that the higher the pressure the more troubles there are through the silent discharge, or whatever it is called. I need only refer to the well-known experiment, in which a third terminal is sealed into the lamp. A galvanometer then shows a current going across country inside the lamp. This is no doubt intimately connected with the life, or rather with the death of the lamp.

I have dealt with the question of high pressure incandescent lamps at some length because the subject is really of vital importance, and is too much neglected. Our technical colleges, and our technical press, and our technical societies pay the greatest attention to questions of a per cent. or two in the efficiencies of dynamos and transformers, and give a good deal of attention to engines and boilers. That is because there is plenty of room for calculations in connection with these subjects; but the incandescent lamp, which at present holds the whole career of the lighting industry in the little curl of flimsy red-hot carbon that can hardly support its own weight, receives no attention at all. How much does the average electrical engineer know about incandescent lamps? The only subject that is treated in the same way is the cable. About half the money in town lighting goes in the cable, a mere fraction in the dynamos and transformers themselves; so the average electrical engineer knows noth about cables.

So far I have only discussed the inca descent lamp; the arc lamp has also to considered. I will not say much about arc lamp just now, but will add a little m when the Nernst lamp is compared with The ordinary arc is limited in pressure about 50 volts, including the series resistan necessary for regulating. The enclosed a is a new development which is more sat factory as regards pressure and as regar consumption of carbon.

The lamp I describe to-night is the inventi of Professor Walther Nernst, of the Universi of Göttingen. Though he is a young ma Professor Nernst's name is already known all modern chemists as a leading authori and original thinker in the field of physic chemistry. It is unusual for a man who h climbed to the top of one tree to jump to t top of another.

Nernst's, like most great inventions, is e ceedingly simple as soon as it is understoo The efficiency of an incandescent body, as f as radiation goes, depends simply on the ten perature. The efficiency of an incandesce lamp, for instance, depends on the temperatu of the filament only, providing there is no los by convection. The carbon will not stand sufficiently high temperature, especially as, i addition to its low specific resistance, th filament has to be long and slender, and thu weak. Nernst, therefore, chose a materia that would stand higher temperatures tha carbon, and his material has the incidenta advantage that its specific resistance is s high that strong rods can be used for hig pressures instead of thin filaments. The mos refractory materials so far used in lighting ar zirconia, which has been used to replace lime i the limelight, and the oxides or so-called rar earths, in the Welsbach mantles. I am aware of course, that many people suppose that th Welsbach mantle is not very hot, treating it as if it were at a temperature, for instance, below the melting-point of platinum. The light emitted is supposed to be due to some special power of selective emission due to the oxides employed. I have had a good deal to do with incandescent gas mantles, and I find no reason to suppose there is any magic effect of this sort going on. The part of the flame where the mantles hang fuses platinum wire easily, and very few materials can stand the temperature without fusing or volatilising. Lime and many other oxides

ilise slowly from the mantles. I do not 1 that the mantles are above the boiling- of lime; I have some idea of its melting-, as I have made a few pounds of melted and run it out on the floor to look at it. Welsbach mantles, which are now chiefly a are at a temperature near their softening-, and in the making are raised to a tem- ure at which they begin to soften.

rnst takes highly refractory oxides as his rial. It does not seem promising, because oxides are notoriously good insulators. such insulators are electrolytes when hot; st, therefore, heats the rods to make them uct, and then heats them electrically, pre- ng a temperature which is within the limits the material can bear without softening. means that he can take the most refrac- bodies supplied by the whole range of iical research, and can heat them to a erature short of their softening point, and hus get an efficiency unknown to workers ie incandescent lamp. Such efficiency means whiteness of light, so long as the ency is not too high. Thus the crater of arc being at a temperature of boiling on, gives a light that is unpleasantly blue. e material is worked up into little white Each rod is mounted on two platinum, a little paste made of refractory oxides applied to the joints. The little rod with o wires is then mounted in a holder which dinary electric-light fittings. As the rods 1 resistance as the temperature increases, the manner of electrolytes, an increase of nt produces a decrease of resistance. This to give some instability in running in lel on supply circuits. This instability rrected, as in an arc lamp which has gous properties, due to a different cause, series resistance. The Nernst rod has fore a resistance in series. This is made exceedingly fine wire, and for ordinary ts amounts to 10 or 12 per cent. of the resistance of the lamp. The consump- including the resistance, is 1·5 watts per e for large lamps, and 1·6 for small lights w pressures. In small or low-pressure s the loss of heat at the ends is larger in rtion.

h a lamp as I have described will not up of itself, for the rod is an insulator cold. The simplest way to start it is to it up with a match, or better with a small -lamp. Such a lamp as this is not only cheap as regards first cost, but very omical in running. The life of rods, running at an efficiency of $\frac{2}{3}$ of a candle per watt, including the resistance, is already more than 500 hours in good specimens. If the Nernst lamp advances as much in the first few years of its existence as the carbon lamp did between 1880 and 1882, it will soon be made so well that the rods last a life-time. When the rod is worn out a new rod with its wire mounts is all that is replaced. The whole lamp is not thrown away at all.

The method of lighting I have described, though it may be used in many cases, such as large public rooms, is really a savage mode of ignition, fit only for dealing with uncivilised commodities, such as gas and tobacco.

The small lamps and the lamps of medium size are in practice started by a heating resistance. This is arranged close to the rod, and in shunt to it. As soon as the rod is hot enough to conduct, its current works a tiny cut-out in the resistance circuit. In large lamps the heating system is a little more elaborate, as the resistance arrangement is arranged as a sort of hood which covers the rod. As soon as the rod conducts, not only is the resistance circuit broken, but the electro-magnet lifts the little hood clear off the rod. In all these forms, the rod and its mounting are replaceable without interfering with the rest of the lamp.

We now have to consider the part the Nernst lamp is probably going to play in the near future.

Compared with the small incandescent lamps, as you deal with a material of much higher specific resistance, it is easy to give both small lights and high pressures. The question of lighting is exceedingly important though it appears trifling at first sight. People are so accustomed to lamps being turned on from the door without any further trouble, that they will generally object to having to light them with matches or spirit lamps, but there are many cases in which it will be quite satisfactory to have one lamp with an automatic lighter to show you the way into the room, the rest being lighted with matches or a spirit lamp as needed. There will be, however, a considerable opening for the cheap, small power, high efficiency lamp; and the disadvantage as to lighting is small in such cases as cafés, restaurants, churches, hotels, railway stations, and in short in most public rooms, is small.

Coming now to the next size, that is to say lamps of 20 to 200 candle-power, and even small lamps in which it is worth while to

have automatic ignition, the first cost of such lamps will be higher than the first cost of incandescents, but as the rod itself has alone to be replaced, that is a matter of very slight importance. This size of Nernst lamp has further every chance of completely ousting the carbon incandescent on the score of cheapness, as to renewals, higher efficiency, better coloured light, and perhaps more especially high pressures. Once the Nernst lamp becomes so general that systems of distribution are laid out to suit it, instead of to suit the carbon lamp, the carbon lamp is practically "out of the running." It must be remembered that the Nernst can compete with the carbon filament at any pressure that suits the filament, but the Nernst lamp can easily go right out of the depth of the filament and have the higher pressures to itself. It must be remembered that at present the cost of cables in a system of distribution is an exceedingly large item.

Turning now to the large lamps, they compete with the arc lamp in efficiency. Of course the efficiency of the arc lamp is not a very definite quantity. The candle-power is generally determined by multiplying the current by two and adding zeros at discretion. All I can say is, that however many zeros the good-nature of the maker may supply, a Nernst lamp taking the same power gives a better light. When carefully arranged on the photometer, the arc may be better in given directions, but a lot of light given in directions that you do not want is not the same as the same light distributed with a uniform spherical emission. The arc lamps shown here will give the audience a good idea of the relative values. The Nernst gives a pleasanter, and of course a perfectly steady light. Coming to costs, the Nernst will be very much cheaper in first cost, but enormously cheaper in maintenance. It also goes quite away from the arc as to pressures. There is no trouble for instance in making large lamps to work in parallel at 500 volts and by using double rods at 1,000 volts. This puts an entirely new development of electric lighting in the hands of the engineer.

There is one point I have said little about yet. The incandescent lamp which is still with us, gives trouble not only because of the low pressure it needs, but also because it demands that the pressure shall be kept uniform. It seems quite possible that the Nernst lamp may be made to stand a much greater variation of pressure than the filament. If this proves true it means an enorm difference in the designing of distribu mains. I do not like to say much about yet as the invention is too young, and too time has been available to make much ce progress in that direction. Results promising, but it is best not to be sanguin

It is difficult to discuss an invention like without being carried away by enthusiasm feel, however, that I have but feebly s forth the probable future of what seems t the greatest invention in electric lighting we have seen for many years. Still I am I have not been too sanguine.

DISCUSSION.

The CHAIRMAN, in inviting discussion, sai Swinburne had fascinated them all by the man which he had put forward all the good points Nernst lamp, including the possibility of going to old habits and lighting electric lamps with a m

Prof. AYRTON, F.R.S., congratulated Prof. on having achieved such a wonderful result b simple means, viz., rendering an insulator cond by heating it; and Mr. Swinburne on the which he had put the matter before the m The knowledge that an insulator could be m conduct electricity by heating it was much olde the recent experiments of Sir W. Roberts-Aust some twenty-three years ago a paper appeared "Transactions of the Royal Society" on th subject of the extraordinary diminution of resi in a solid electrolyte by heating. In Japan, of zinc and copper were put on each s a glass plate, which was heated, and the e motive force passing, as indicated by a high ance voltmeter, after short circuiting the appeared almost as rapidly as if the had been immersed in dilute sulphuric It had also been known ever since carbon fi lamps had been on the market that there were difficulties connected with them, and many ments had been made, and patents taken ou the object of using refractory earths, but, app no one before Professor Nernst had thought simple expedient of heating a very good i with a match or spirit lamp, applying a cur suitable potential, and thus obtaining a brillian such as they had now seen for the first time result was clearly of enormous commercial impo and would be an entirely new departure in glo electric lighting. It was also extremely int from the purely scientific side, touching on a q which Mr. Swinburne had passed over rather as if it was only a few foolish people who there was something in the Welsbach mantle wh did not entirely understand. This invention s at any rate, that illluminating gas was not n

ning light by incandescence from the rare Some five or six years ago he asked an of his to look up the literature on the of the Welsbach burner, and see if any report n made throwing any light on the question the effect of the burner depended solely on n temperature. He gave him a reference erman paper in which experiments were which seemed to show that the high tem- was not the sole factor. Later on he d the matter with a very distinguished English , who agreed in the view that it was not question of temperature, and a year or two ds he again discussed it with Professor Elihu n in America, who took exactly the same Many people thought that the material of which ntle was made had the power of absorbing oxy- m the air or the gas, and compressed it, much as black absorbed hydrogen and oxygen, and so these gases to burn under considerable molecu- ssure. It was not merely that the Bunsen flame he material to a high temperature, but that the l air were compressed together in the pores of terial, so that the gas was burnt under pressure, you got a much higher temperature than you ise would. In the glow lamp, as they were aling with gas, it did not seem that the mate- uld play any such part. There seemed to be ing in that idea because it was necessary for the to be a certain exact composition; you could ke thoria or zirconia at random and use it; you ave a certain definite combination to produce cient mantle. In fact it was the addition of r cent. of ceria which converted the Wels- urner from a ghastly failure commercially into derful success. He should like to know whether antle was not at a much higher temperature he flame which surrounded it, and whether a ular combination of materials did not reach a higher temperature than another combination sed in the same flame. If so, it was not merely the rature of the flame which produced the result. was one great advantage about the Nernst lamp, not seem to require a thin glass bell and a m, and thus got rid of a very serious difficulty, se these bulbs were very fragile, and were easily yed by a touch of a broom or carelessness in ge; many lamps also were defective, not from ault in filament, but because the vacuum was fect. He should like to know the reason of lifference in the colour of the light of the bach and the Nernst lamps—was it a difference terial or in temperature? He understood from olleague, Dr. Armstrong, who visited Professor st some time ago, that it was essential to use an nating current, as with a direct current the in- escent rod soon ceased to make good contact one of the platinum terminals.

r. HIRAM MAXIM said he had always under- l that the light in the Welsbach burner did not depend entirely on the temperature. There were many things in nature which gave light without any heat at all; such were glow-worms and fireflies. His opinion was that any substance, if there were any, which did not volatilise at all, would give a light proportionate to the temperature; that platinum or iridium, or iron, if the iron was not burnt, would all give the same light at the same temperature, provided none of the material was wasted. Of course if the least particle passed into the air the flame would be coloured. In all probability the light emitted did not increase as the temperature directly, but as the square, some said as the cube, and some said as the fifteenth power of the temperature, and he was inclined to think that a slight increase in temperature increased the lighting power a great deal. In the Welsbach burner the light was not white, and that, he thought, indicated that some change was going on which made the apparent light higher than that due merely to the temperature. If carbon were heated to the same temperature it would not give the same light.

Mr. R. S. ERSKINE said it would be an enormous advantage to central supply stations when these lamps came on the market. There was a great difficulty in getting satisfactory 200-volt lamps, though he did not know that they were much worse than the 100 volts. The fact was the public were now educated up to a much higher standard of light, and wanted much more than satisfied them some years ago, when they were only used to candles and ordinary gas burners. Those who were formerly well satisfied with two wax candles in their dressing-room would now put up two 32 candle-power lamps over their dressing table, and the lighting all through the house was on the same scale. They were not content with an 8 candle-power lamp that gave eight candles, but wanted it overrun so as to give ten or twelve candles, and the 200-volt lamps would not stand this; the old 100 volts stood it to a certain extent, but soon got inefficient. The great trouble with all central stations was that the lamps took more current than they used to. It looked as if these lamps would give the public what they wanted at a reasonable price.

Mr. W. M. MORDEY thanked Mr. Swinburne for speaking the truth about the 200-volt lamps. The supply of lamps was a matter which really required attention, because it led to a great deal of dissatisfaction. He thought the correct plan would be for the companies to supply not electricity, but light; and instead of persuading customers to buy lamps of any particular kind, they should make an inclusive charge, and supply them with lamps themselves, this would prevent dissatisfaction. He congratulated the Society on this paper, which he thought would mark a new epoch in electric lighting; it was the first page in a new volume, recording an invention which would rank with that of the Swan lamp, since which there had been nothing brought forward so pregnant with results. They must also congratulate Professor

Nernst on his invention, and take care that he had the credit of it, and was not robbed by a number of people, who would be immediately writing to the *Times* to say that they did the same thing in their back kitchen 20 years ago. That was what always took place in the case of a new invention. Mr. Maxim had anticipated what he was about to say about the glow-worm. Professor Langley, in America, dealt with the radiation from fireflies and glow-worms in a paper a few years ago, and gave a diagram showing the total radiation, and what proportion was luminous; the result proving that the glow-worm had solved the problem which Tesla, Hertz, and many others had been working at, of making nearly the whole of the rays luminous. If they could only get a glow-worm to come and read a paper explaining how it was done, Dr. Nernst's lamp would have no future before it. One advantage these lamps possessed was that they would be able to light their cigars and pipes at them. He agreed with Mr. Swinburne that the possibilities of the carbon filament were about exhausted; there had been very little improvement for a long time, and it was a remarkable thing that just when the carbon filament was failing to meet their requirements, this new invention should be made, which seemed to meet the case. It was like the discovery of gutta-percha at the critical period, which got electric cable-makers out of their difficulties. But, though the new lamp was evidently a very robust child, it was still a child, and it would at any rate take a little time to displace existing lamps. If lamp companies' shares went down at all on account of the Nernst lamp, he would like to buy some, as they would have time to rise again before the incandescent carbon disappeared.

Dr. FLEMING asked if there was any deterioration in the quality of these lamps after a time, such as occurred with carbon filaments and Welsbach mantles; because this would be very important in considering the commercial value of the invention. If the lamp only required 1 watt or $1\frac{1}{2}$ at starting, and, after a few hours' work, 4 or 5, it would be a serious disqualification. It was well known that most of these radiants did deteriorate after a time; with the lime-light, for instance, after a few minutes, the radiant quality of the lime diminished, although it was played upon by an oxy-hydrogen flame at a constant temperature; and turning the lime round would markedly increase the amount of light on the screen.

Major FLOOD PAGE, having congratulated Mr. Swinburne on his paper, said he was much interested in this subject, though he was not a scientific man. When he saw Professor Nernst some months ago, in Germany, he was very much astonished to find that so young a man had been able to attain such a high scientific position. Mr. Swinburne had spoken of the carbon lamp having reached finality, but he might say those connected with carbon lamps, as he was, were as much interested as anyone in this new departure. They had a higher interest than that of any particul lamp, and that was in the advance of electricity. He quite agreed that nobody but Professor Nernst could claim the credit of this invention. It was one everybody had been expecting, and it could be worked in conjunction with existing systems, so that all who were connected with electric work would find themselves indebted to Professor Nernst. In the old days they had had Maxim, Edison, and Swan; and some people thought one was going to kill the other, but instead of that they all helped the general advance. This was to a certain extent going back, for Swan first worked at a rod, but, he believed, it was an advance which might benefit all connected with electricity.

Mr. H. COLEFAX said several applications for patents had already been put in, which appeared to claim the benefit of this discovery, but he did not think they would prove successful. With regard to the question of deterioration, he was told by Professor Nernst, some eight months ago, that as far as he could discover, these lamps did not deteriorate, but, of course, this could only be proved by experiment; but if it were so it would be very remarkable, seeing that in every other form of incandescent lighting yet tried there was this deterioration. He should be glad if Mr. Swinburne could tell them what it was which limited the life of the filament, because, when he saw Professor Nernst, he did not think he had then arrived at any explanation. He was astonished at the progress which had been made in the eight months since he first saw the invention; the limit then was 200 hours, the first experiments only having attained 40 hours.

Mr. CAMPBELL SWINTON said Professor Ayrton was not strictly accurate in saying that this was the first attempt to use a heated electrolyte. Some twenty years ago, Jablochkoff showed a lamp in London consisting of a strip of kaolin, along the top of which he put what he called a match, which consisted, he believed, of carbon mixed with treacle; this conducted the electricity—100 volts—until it heated the kaolin, and that then formed the conductor. He would not go into the question of how far this was an anticipation of the present invention, he only wished to correct the impression that nothing of the kind had been tried. They must all admire the great advance which had now been made, and they knew that the Jablochkoff lamp never came to anything. With regard to the lighting power of incandescent gas mantles, he had made many experiments on them with cathode rays, by which you could heat them to a very high temperature without the use of gas in the ordinary sense, and he found there was no appreciable difference in the amount of light given by a mantle of pure thoria, and one with the addition of a small per-centage of ceria.

Mr. SYDNEY MORSE said he was interested in this question on the commercial side, and especially as connected with the competition of mu

[author]ities, who were now commencing to manu[facture] and sell electric fittings, which he feared [would] seriously interfere with the progress of in[vention]. They had heard that invention in con[nection] with carbon filaments was exhausted, but [this] opened up a new industry, which he hoped would [be tak]en up and improved by English engineers and [invent]ors, for they could not suppose that everything [had no]t been done.

[Mr.] J. G. Lorraine asked what amount of heat [was e]mitted by this lamp compared with an ordinary [incand]escent one.

[Mr.] A. H. Dykes asked what was the power [requir]ed for these lamps. He had been working out [a sch]eme for street lighting, and he found the diffi[culty] was that, while arc lamps were too large, [ordina]ry incandescent lamps were not a great success. [This] lamp appeared to have many advantages for [such p]urposes, and particularly the volume of light[-giving] material being so much larger than a carbon [filame]nt, it would have much greater penetrative [power] in foggy weather. With regard to lighting up, [a ma]n could go round and apply heat underneath [the] lamps as well as he could turn on the ordinary [la]mps.

[Mr.] Swinburne, in reply, said the question of the [tempe]rature of a Welsbach burner was a very large [subjec]t, with which he could not attempt to deal [now]. If you examined a burner with the mantle off, [there] was a zone of very high temperature, which [would] easily fuse platinum; but most measurements [of it] were erroneous, because they were taken with a [therm]opile, which never got the real temperature of [the bu]rner; the great difficulty was to get what was [in the] burner to the temperature of the burner. In [deali]ng with the light given by incandescent bodies it [must] be remembered that the light depended on the [emiss]ivity. If the only temperature at which you got [good] light was very high—very close to the tempera[ture o]f the gas—you must use something of very low [emiss]ivity; if it were large, the heat given by the burner [was r]apidly given off, and if infinite the temperature of [the m]antle would remain at the average temperature [of the] room, and you would not get any light. On the [other] hand, if the emissivity were very low, though [the m]antle would get to a high temperature, it would [not g]ive light for want of emissivity. A pure white [oxide], such as pure zirconia, gave very little light, [becau]se the emissivity was too low, though the [temp]erature was high. To get the highest efficiency [you] must have emissivity enough to give plenty of [light] without robbing the flame of its heat too soon. [With] a white oxide like thoria you did not get much[light], but if you added a small per-centage of ceria or [some] other coloured oxide—it did not matter much what [—you] got light. A great deal of unnecessary mystery [had b]een introduced into the subject because it was [know]n that erbia gave some curiously characteristic [spect]ra, but erbia was only present as an impurity. Another point was that cerium had two sets of compounds, and it was supposed that it was continually hopping backwards and forwards from one state of oxidation to another. In dealing with a subject like this, he thought the proper way was to take a simple explanation if it fitted the case, and only if it did not to go to a more complicated one. He saw no reason to suppose that temperature did not account for the results, if it would fuse platinum, and if it would soften the mantle, as it would. In making Welsbach mantles—though having advised the company he must not say everything he knew—they were sometimes raised to such a high temperature that they softened, and then they gave more light. Professor Ayrton had quoted several anonymons authorities, but had not given the reasons for their opinions, and so it was impossible to deal with them. They involved questions of thermo-dynamics into which there was not time to go. The case of spongy platinum was altogether different, there was a chemical combination started by the heat, which would not otherwise take place. Here there was no reason to suppose there was such a combination, spongy black would give no light, and a solution of platinum put upon a mantle would destroy its light-giving power. He believed that colour was largely a question of temperature; but you could produce different colours by using different materials. The emission was the complement of the absorption. A blue body when heated gave an orange light. With regard to a vacuum, its effect was to get rid of convection. If you tried to heat a long thin filament of carbon, it would be inefficient on account of convection; but with a short, thick rod the convection was not serious. Practically, he believed these Nernst lamps would not work in a vacuum. He had not tried many experiments himself, but so he was informed. The reason generally given was that electrolysis was going on, and that oxygen was being absorbed from the air at one terminal, and being given off at the other. That was Professor Nernst's explanation, but he thought there was another factor to be taken into account. It was perfectly simple on paper to electrolyse salt, and get out chlorine and sodium; but when you tried it you did not get either. The reason appeared to be that the chlorine and the metal were dissolved to some extent in the fused bodies, and got across very quickly. He did not think true electrolysis took place to any extent, but there was a continual diffusion of the substances across which was undoing the work of electrolysis all the time; but that was not sufficient to make it work properly in a vacuum. All the lamps shown were on the alternate current, but he had tested them with the direct current and found their efficiency continued right through. That was some six months ago, when they lasted 200 hours; now they had got to 500 hours, and he had no doubt they would go much higher. He did not know anything

about glow-worms, and doubted whether any one else did; but he did not think such questions had much to do with the matter; it was more a question of the red-hot poker order, quite simple. With regard to the emission of light at a given temperature, it was not the least likely that there was any such simple law as Mr. Maxim had suggested. The simple law would be as to the emission of power or energy. Light was only a certain small octave of vibrations that affected the human retina, it was not distinct from heat, or the radiations of still higher frequency. It was not likely there was any definite law as regarded light; probably it depended, for one thing, on the eye looking at it. With regard to deterioration and its cause, after running some time the material appeared to get crystallised; what else happened he did not know. Probably there was a gradual tendency for the rod to get uneven; then it would get more heated in one part, and softer, until at last it melted. Professor Ayrton seemed to think that the compound in the Welsbach mantle was chosen entirely for giving light; but anyone who used those lights knew that the strength of the mantle was of great importance. You could get a very good light from yttria, but you could not get a strong mantle that would not warp. The manufacturer had to consider strength, portability, and durability; and one point about that was that both the Welsbach and Nernst were at a very high temperature, just short of the fusing point, at which the material very slowly evaporated. If you took a thoria mantle, and put lime on it, it would give a very nice light at first, but the lime would soon volatilise; so would many other substances; ceria went off quicker than thoria, and the result was that after running a thoria mantle with a small amount of ceria for some time you had a pure thoria mantle. It was not that the power of the ceria was exhausted, but that it was not there. He did not know what caused the deterioration of the lime light; probably the lime really began to sinter together, and therefore you did not get the same temperature as before. He congratulated Major Flood Page on the exceedingly broad-minded view he had taken of the subject. With regard to the early Jablochkoff lamp, he had no information; his own impression was that the Jablochkoff candle was the only thing which was at all successful; that was in use in 1878. There was another lamp which depended on a hot material between the poles called the Lampe Soleil, in which an arc was struck across a surface of marble which got very hot, and finally conducted and gave an illuminant surface. The cathode rays experiments referred to by Mr. Swinton bore out what he had said about the earths, that it was simply a question of temperature. There was another inventor, he believed, working on a lamp with cathode rays, and no doubt they could be made to give an efficiency equal to the Nernst, if the earths were raised to a sufficiently high temperature. With regard to the amount of heat given off, it depended on the amount of power used; if you took 100 w... probably nearly 100 would go off in heat, as o... small per-centage of the energy was converted ... light, and until Mr. Maxim and Mr. Mordey c... tame their glow-worms he was afraid it w... always be so.

The CHAIRMAN, in proposing a vote of thank... Mr. Swinburne, reminded the audience that, wit... their enthusiasm, the commercial success of this ... lamp depended on the price at which it was offered ... as to this they had, as yet, no information. W... electric accumulators were first discovered, it ... supposed they would revolutionise the indu... and do all sorts of wonders; but though they ... been certainly useful, they had not done what ... expected of them. In the case of these lamps, if ... were sold at 1s. 1d., all charges included, an... ordinary carbon lamp was sold at 1s., he feared ... latter would be generally purchased.

The vote of thanks was carried unanimously ... the meeting adjourned.

Miscellaneous.

HISTORY, DEVELOPMENT, AND VARIE... OF THE PIN AND NEEDLE.*

There is no record of the period when pins ... needles were first employed in their primitive f... The earliest needles were not pierced at the end o... site the point; but the pre-historic needle was ... an awl, which served to make holes in furs or ... that were worn ages before textile fabrics we... vented. The long underground roots of plan... bindweed, and leathern thongs, were passe... hand through the holes thus made; and it was ... in more recent times that the idea was concei... attaching the thong to the primitive needle, for f... it to follow the path thus made, whence aros... first idea of the needle proper. In remains o... Stone Age splinters of stone, pierced with a hole ... end opposite the point, are met with; and it is e... that these tools, sometimes a little curved, serv... needles in those remote periods.

Flat needles with a split in the end opposit... point, are found among the remains of the B... Age, the two branches being slightly separated, ... brought together again, and crossed at their ... whereby a kind of eye was formed, while th... parts were sometimes united by a rivet. It i... known when the eye was first formed by piercin... end, which must have been a difficult operatio... cylindrical rod of iron or steel, so that, subsequ...

* "Die Nadel und ihre Entstehung, eine technolo... Skizze," von Franz Bütgenbach. Aachen. Ignaz Schw... 1898.

s flattened where the eye occurs; but no can be formed as to the shape of these :ause they could not withstand atmo- ences, while, on the contrary, specimens / pin, for which bronze or the precious : often employed, have been very well The true type of a sewing needle was, so Greek and Roman times, pointed at one :rced at the other; and it is only when machine was invented that needles were the eye near the point.

ıe period when the first true needle made ınce be unknown, as also its exact form, be no doubt that this essentially domestic had attained a very high degree of perfection times. So ancient a poem as Homer's " gives a detailed account of the mantle embroidered by Penelope for Ulysses on his or the Trojan expedition. It was not, how- n only who used the needle, because needle- d among the fine arts, and it is probable that derers of the period made their own needles, late as a century or two ago, painters made ıes and prepared their own colours.

ınly about 1785 that the first mechanical oducing the double steel rod, for making :s joined together, was introduced. At first, :fore they were completely finished, under- at many manual and mechanical operations, :veral times between the factory and the s dwelling; and it was only about 1870 needle was made for the most part by l methods, while during the last fifteen years been entirely finished in this manner.

ıeffield, Aachen, or Aix-la-Chapelle, has been for the needle industry during the last two and it is in this city that were established mechanical appliances connected with it. e invention and perfection of the pointing a skilful workman could point 25,000 ı a day of ten hours; but a machine now this operation with greater precision on ceedles in the same time and with one work-

eedle manufacture is now concentrated in the United States of America, and Germany, ix-la-Chapelle, which is by far the most im- eat, and also at Iserlohn, Altona, Schwabach, , and Ichtershausen. While no needles in France, that country produces a large of pins—it is stated ten thousand millions— ısuming more than ten millions daily, so that nports of this domestic article are considerable. are at least 250 varieties of the needle for lone, to say nothing of those for embroidery, cartridge-making, book-binding, sail-making, larding (in cookery), and many other pur- ore or less connected with the original object. ɔin, called Steck-Nadel in German, has even rieties than the needle, while being still more ınd generally used. The pin must also have been employed before the needle, for connecting the skins which served as garments before the idea of sewing them together was conceived. Examples of artistically wrought pins are found among Egyptian as well as Greek remains; but it was especially the Romans who made very elaborate fibulæ, which have developed into the modern brooch. Simple pins with mere head, shank and point, were, however, largely used in antiquity; and the estimation in which they were held is proved by many proverb and popular sayings connected with the pin in various languages.

Different kinds of wire are required for making the pin and the needle; for while that of the latter must be stiff and yet yielding, to a certain extent, as well as polished to the highest degree, that of the pin must also possess a certain amount of stiffness, while it must also permit of bending without being broken, though a too highly-polished pin becomes easily detached. Scarcely a hundred years ago the steel pin was rarely used; but this variety has now been so much improved that the steel pin may be said to have now come into general use. The lengths of steel wire are prepared in the same manner as those for the needle, so as to constitute two pins, separated into equal parts before the operation of heading; and one end must be softened before receiving the head. For this delicate operation alone an automatic machine has been devised, that brings each head in turn within the influence of small gas flames, and which can soften 150,000 shanks in a day, five or six machines being tended by one person. Very small brass or iron pins are headed by simple "upsetting" or crushing down the end, as in riveting; but for those of larger size, the heads must be prepared previously, in a particular and very ingenious manner, from a piece of wire twisted spirally, two and a-half turns being required to make the head, of which 500,000 may be produced daily by one worker. Whereas before 1835 each pin was headed separately by hand, between five and six thousand pins may now be headed mechanically in ten hours.

Enamel-headed pins constitute a branch of industry special to Aix-la-Chapelle, where was first conceived the idea of adapting the "enamel" or glass head to the steel shank. A manufacturer of that city, seeking means for utilising the needles spoilt in manufacture, conceived the idea, after visiting some Venice glass bead factories, of fixing the bead on the end of one of the "waster" needles, so as to form a pin; but it was only after long and tedious trials that he succeeded in attaching the enamel strongly enough to the shank, and also in finding a composition of glass sufficiently tough to stand the usage to which a pin may be subjected.

The general introduction of the steel pin was not easy, because it was found that the early examples readily became detached, owing to their high polish, while they often broke through want of sufficient pliability. During the last thirty years, however, the consumption of steel pins has greatly increased; and at a single Aix-la-Chapelle factory it has been found

necessary to put up separate works to make the glass for heading pins, that now turn out half a ton of "enamel" daily for this purpose, while the same establishment consume two-thirds of it. The consideration that only 0·2 gramme (3 grains) of this glass is, on an average, required for heading a pin, will afford some idea of the enormous quantity of pins that can be headed with half a ton.

Owing to the greatly increased consumption of steel pins, the "waster" needles now form only a very slight proportion of the shanks required. For preparing the latter, pointed lengths of iron wire are introduced, a million together, into a cast-iron drum containing a special carbon dust for cementing them—*i.e.*, turning them into steel, by subjecting them to the necessary heat during a certain length of time. This process imparts the necessary degree of hardness; and the almost imperceptible flange formed in cutting the wire to length is favourable to the holding fast of the head, while it is seldom that an enamel-headed pin loses its head.

The enamel, or glass, has to be made specially for the purpose, because it must be easily fusible, and must also remain viscous sufficiently long for the forming of the head, while it must also be bright without the necessity for polishing, and yet not brittle. Two workmen with iron rods, like that of the glassblower, except that they are not hollow, take up on the end of them sufficient glass, which is rounded by turning so as to assume the form of a pear. With their rods they proceed quickly to a drawing-out walk, like a rope-walk, straight, horizontal, and about 50 metres (56 yards) long. Standing in the middle, the men unite the balls of viscous glass, and then proceed in opposite directions to the ends of the walk, thus drawing out the glass to the whole length, its thickness varying with the rapidity of the movement between three and seven millimetres (mean 3-16th in.), after which the glass rod is cut into lengths and made into bundles.

The head is formed and fixed at the same operation with great skill by a work-woman seated before a table, on which are mounted a frame, about 15 cm. (6 in.) high, carrying the glass rod placed horizontally (its end being brought to a convenient distance) a gas-burner at about the height of the rod and a air-jet for giving a blow-pipe flame, all adjustable. The work-woman, who has before her a quantity of steel shanks, takes several in each hand and passes each one in succession, alternately with the right and left, into the heated and viscous portion of the glass rod, withdrawing the shank by a special turning movement so as to take up a little of the glass; and a turn of the thumb and first finger gives the shank a rotary movement, so that the glass taken up becomes formed into a head which remains attached to the end of the shank, the head cooling while the complete pin falls into a channel. This somewhat complex operation is executed with remarkable address and rapidity; and a skilful worker can head from 25,000 to 30,000 pins daily.

There are fifteen sizes of these pins, t of which vary in diameter from 1·5 to 3·5 n — from 1-16th to 1-8th of an inch— length of the shank varies from 1·5 to 5 c (19-32 in. to 2 in.)

According to the report of the Aix-la Chamber of Commerce, there are now in forty pin and needle factories, employing 4,000 workpeople, or two-thirds of the tot engaged in that industry in Germany. F needles alone from 800 to 900 tons of stee worked up yearly; and the following are th of the principal finished products that are t per annum:—Hand-sewing needles, 3,100 sewing machine needles, 65,000,000; vari needles, 35,000,000, and pins 1,300,000,000; total of 4,500,000,000, representing a 6,000,000 Marks (£300,000), and giving price of 1s. 4d. per thousand, although t actually vary from 7½d. to 8s. per thousand.

Of the lightest needles there are forty in a and therefore 1,200 in an ounce, while no 7,000 of the lighest enamel-headed steel a pound avoirdupoise.

Manufacturers who produce none but n the highest quality complain bitterly th harm is done to the Aix-la-Chapelle m inferior products, which can scarcely be dist by their appearance from those of good While a good needle may be bought at th ten a penny, those of inferior quality are sold a penny; but the difference in price is far n set off by frequent breakage, bad work, dif threading, wearing of thread, and loss of say nothing of temper. It is only the mi who gains by the bad needle, the producer sumer both suffering.

HUMAN HAIR INDUSTRY IN FR

According to recent reports of the repres of the United States Government in Fra central departments of Corréze, Creuse, Che Haute Vienne, and Dordogne are frequent by hair merchants having orders for human the United States. The dealers in this a that the inhabitants must be very poor to p girls to sell their hair; then there must be a variety in quality and shade to meet the requ of the market, and thirdly there must be a re place where those requiring to sell their hair buyers. All these conditions are met in th mentioned departments. The soil is poor, st hard to cultivate; these low mountains migh be called the foothills of the Alps. They ar most part bare, or covered with heather pasture for goats and sheep. Almost all are masons, stonecutters, and builders. Th their homes in the spring for different parts o to work at their trades, returning when em

ıger obtainable. The women and girls look farm and tend the cattle, goats and sheep. ıcome is very small, and in order to buy a ss or provide some luxury, the girls consent ll but the front part of their hair. Ashamed niliated by this act, however, they always *coiffe* or handkerchief to cover their shorn During the fair of St. Loup, and the fair that on the last Thursday of August each year, e regular meeting places where the seller and nake their bargains. The average price ıll, long head of hair is about 8s., but an ınally fine growth will bring 25s. These re counted upon in the annual income of ıt family. The hair shipped to New York hrough the hands of commission houses in Their agents make the purchases in the es, the payments being often made part in ınd part in dry goods. There is a difference 10 between the buying and selling price of To make up lots of hair, the darker shades of nch are mixed with blonde and light hair from ıy and Switzerland. A few ounces of white is ıt in a bunch of cheap stuff to make it sell. In instances the French and German buyers ge, so as supply the markets of the two es. This industry is increasing annually, and babilities are that it will be more extensive in ıre than at present.

General Notes.

SULAR AGENTS. — On the initiative of the Union des Charbonnages, Mines et Usines ıgiques, the Federation of Commercial and ial Associations has decided to found at Liége l or college of advanced commercial and con- tudies, with a programme specially arranged ıing out consuls and commercial agents.

ADELPHIA EXHIBITION, 1899.—The follow- gest of an Act of Congress (so far as it ıs foreign exhibitors) providing for a national ion of American products and manufac- ıt Philadelphia this year (1899) for the ıgement of the export trade has been com- ted by the Lords of the Committee of l on Education :—" There may be admitted l exposition such articles not of American cture, and such other objects as may conduce nterest of the exposition and may be useful for ison with American products and manufac- All articles imported from foreign countries sole purpose of the exhibition will be admitted duty or customs fees." The Act stipulates that ited States will not be liable for any of the oings, proceedings, or representations of the of Trustees of the Philadelphia Museums or the Philadelphia Exposition Association, under whose auspices the exhibition is to be held, except under the conditions as set forth in the Act.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

FEBRUARY 15.—"The Balloon as an Instrument of Scientific Research." By the Rev. JOHN M. BACON, F.R.A.S. Captain BADEN-POWELL will preside.

FEBRUARY 22.—"Electric Traction and its Application to Railway Work." By PHILIP DAWSON.

MARCH 1.—"Leadless Glazes." By WILTON P. RIX.

MARCH 8.—"Cornish Mines and Miners." By J. H. COLLINS, F.G.S.

MARCH 15.—"Liquid Fuel." By Sir MARCUS SAMUEL. Sir EDWYN S. DAWES, K.C.M.G., will preside.

MARCH 22.—"London's Water Supply." By WALTER HUNTER, M.Inst.C.E.

Dates to be hereafter announced :—

"Preservation of Timber." By S. B. BOULTON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MARCH 9.—"Leprosy in India." By H. A. ACWORTH, C.I.E., late Government Municipal Commissioner for the City of Bombay.

APRIL 13. — "Judicial Reforms in Egypt in Relation to the Indian Legal System." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive.

MAY 11.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

MAY 25.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

The meeting of March 9 will be held at the Imperial Institute; those of April 13, May 11 and 25 at the Society of Arts.

FOREIGN AND COLONIAL SECTION.

FEBRUARY 28.—"Persian Trade Routes." By A. HOTZ.

MARCH 21.—"The Commercial Development of Germany." By C. ROZENRAAD, F.S.S., and Fellow of the Institute of Bankers.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

February 21.—"Vitreous Enamels." By Cyril Davenport. Sir Owen Roberts, M.A., D.C.L., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Archibald Sharp, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

Lecture I.—February 20.

Introduction—The modern bicycle—The frame—Strength and stiffness—Pedal pressure—Chain-struts—Round, D, and rectangular tubes—Frame of lady's bicycle—Tandem frames—Front-fork—Spring-frames.

Lecture II.—February 27.

Ball-bearings—Hubs—Pedals—Crank-brackets—Steering-head — Adjustment — Wheels — Direct-spokes—Tangent-spokes—Rims—Materials used in cycle construction—Steel—Malleable-iron castings—Wood.

Lecture III.—March 6.

Driving gears—Length of crank—Block chain—Roller chain—Chain-wheels—Bevel gear—Lloyds' cross-roller gear—Compound gears—Two-speed gears—Free-pedals—Tricycle-axle.

Lecture IV.—March 13.

Steel, rubber, and pneumatic tyres—Detachable tyres—single-tube tyres—Tubeless tyres—Valves—Inflators—Side-slip—Brakes—Saddles.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 13...United Service Institution, Whitehall, S.W., 3 p.m. Major E. S. May, "Artillery in Conjunction with a Force Awaiting Attack."

Imperial Institute, South Kensington, $8\frac{1}{2}$ p.m. Richard Davey, "Cuba."

Geographical, University of London, Burlington-gardens, W., $8\frac{1}{2}$ p.m.

Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Professor W. B. Bottomley, "Darwinism."

Tuesday, Feb 14...Royal Institution, Albemarle-street. W., 3 p.m. Prof. E. Ray Lancaster, "The Morphology of the Mollusca." (Lecture V.)

Asiatic, 22, Albemarle-street, W. 4 p.m.

Medical and Chirurgical, 20, Hanover - square, $8\frac{1}{2}$ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. Jeremiah and P. Head, "The Lake Superior Iron Ore Mines, and their Influence upon the Production of Iron and Steel."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Photographic, 12, Hanover - square W., 8 p.m. Annual General Meeting.

Colonial Inst., Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir Robert Giffen, "The Relative Growth of the Component Parts the Empire."

Wednesday, Feb. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Rev. John M. Bacon, "The Balloon as an Instrument of Scientific Research."

Meteorological, 25, Great George-street, S.W. 7 p.m. 1. Mr. Edward Mawley, "Report on the Phenological Observations for 1898." 2. Profess[or] W. M. Davis, "The Circulation of the [Atmos]phere."

Microscopical, 20, Hanover-square, W., [...] Mr. Julius Reinberg, "Exhibition of Objec[ts] by Multiple-colour Illumination."

United Service Institution, Whitehall, S[.W.,] p.m. Major-General R. L. Dashwoo[d] "[...] French in Newfoundland."

Archæological Association, 32, Sackville-st[reet], 8 p.m.

Patent Agents, 19, Southampton-building[s,] $7\frac{1}{2}$ p.m. 1. Mr. A. Du Bois-Reymond, "[Pa...] Actions before the German Law." 2. D[iscussion] on Mr. A. V. Newton's paper, "Proc[edure in] Patent Litigation—A Reminiscence and [...] look."

Mining and Metallurgy, Geological [...] Jermyn-street, S.W., 8 p.m. 1. Disc[ussion on] Mr. Franklin White's paper, "Notes [on] Crushing on the Witwatersrand." 2. M[...] Thomas, "Notes on Economical Mining a[...] United Gold Mine, New South Wales." [...] Mervyn Smith, "Mica Mining in Benga[l]"

Thursday, Feb. 16...Royal, Burlington-house, W. [...]

Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. [...] Gilbert C. Bourne, "The Genus *Lemnal*[...] with an Account of the Branching Syste[m] [...] Order Alcyonacea." 2. Messrs. J. H. B[...] C. H. Wright, "Some African *Labia*[...] Alternate Leaves." 3. Messrs. Jame[s] [...] Melvill and Robert Standen, "Repo[rt] [...] Marine Mollusca obtained during the Fir[st] [...] tion of Prof. A. C. Haddon to the Torres [...]

Chemical, Burlington-house, W., 8 p.m. [...] W. N. Hartley, "The Absorption Spec[tra] [...] Constitution attributed to Cyanuric Acid[.]"

London Institution, Finsbury-circus, E.C[., ...] Dr. C. W. Pearce, "Samuel Wesley—[his] Times, and Compositions."

Society for the Encouragement of Fine Art[s, ...] duit-street, W., 8 p.m. Mr. T. R. Sper[...] "[...] Elements of Design in Painting."

Royal Institution, Albemarle-street, W[., ...] Dr. A. Macfadyen, "Toxins and Anti[...]" (Lecture II.)

Historical, 28, Jermyn-street, S.W., 5 p.m. [...] Meeting.

Numismatic, 22, Albemarle-street, W., 7 p[.m.]

Friday, Feb. 17...Royal Institution, Abemarle-s[treet,] 8 p.m. Weekly Meeting. 9 p.m. M[r. R. R.] Holmes, "George the Third as a Collect[or.]"

Quekett Microscopical Club, 20, Hanov[er-square,] W.C. Annual Meeting, 8 p.m.

Geological, Burlington-house, W., 3 p.m. [...] General Meeting.

Saturday, Feb. 18...Irish Literary Society (at the [...] the Society of Arts), 8 p.m. Mr. F[...] "The Jacobite Songs of Ireland."

Royal Institution, Albemarle-street, W[., 3 ...] Lord Rayleigh, "The Mechanical Pr[operties of] Bodies." (Lecture II.)

Education Department, South Kensington[, ...] S.W., $3\frac{1}{2}$ p.m. Mr. J. H. Pollen, "Furn[iture...]"

Erratum.—In the report of Mr. Sydney [...] remarks on "The Cost of Municipal Enter[prise" in] the *Journal* for February 3rd, page 240, [...] from the commencement of the paragr[aph, for] "Postmaster-General" *read* "Attorney-[General,"] and line 8 from the bottom of the col[umn, for] "sentiment" *read* "sanitation."

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FRIDAY, FEBRUARY 17, 1899.

communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEXT ORDINARY MEETING.

n consequence of the indisposition of Mr. ILIP DAWSON, his paper on "Electric ction," announced for the 22nd inst., has l to be suddenly postponed. In its place a per on "The Gold Mines of West Africa" l be read by Mr. JAMES IRVINE.

LIST OF MEMBERS.

The new edition of the List of Members of Society is now ready, and can be obtained Members on application to the Secretary.

Proceedings of the Society.

DJOURNED ORDINARY MEETING.

The discussion on Mr. DIXON H. DAVIES'S per on "The Cost of Municipal Enterprise," d on Wednesday, February 1st, was re-ned on Thursday, the 9th, Sir WESTBY B. RCEVAL, K.C.M.G., in the chair.

he CHAIRMAN said this was a special meeting, ed to give a further opportunity of discussing paper on "The Cost of Municipal Enterprise," Mr. Davies. The Attorney-General was unable be present that evening, and the duty devolved n him, therefore, of presiding. Those who had rd the paper read would admit that it opened in ery able manner a most important subject; and he ed they would have that night champions both of at might be called the progressive policy of nicipalities, and those upon the other side. He ld first call upon Lord Wemyss.

he Earl of WEMYSS said he thought it would be l if some practical turn could be given to the cussion by passing a resolution emphasising what was in the paper, as coming from such a body it would have a material bearing on the question in which they were all interested. He, therefore, drew up the following resolution:—"Having regard to the numerous Local Bills now before Parliament, containing provisions for trading by municipal authorities, it is desirable in the interests of the ratepayers and of national progress that such powers should be suspended until a joint committee of both Houses of Parliament, or until a royal or other commission has inquired into this matter, and defined the extent to which municipal trading shall be sanctioned by the Legislature, and that a petition to this effect be presented to both Houses of Parliament." However, he was informed that resolutions were not possible at these meetings, but that it was competent for the Society itself to meet and petition in the sense of the motion. He hoped the Society might be induced to do so, and that the result of the discussion would be a petition on behalf of the Society practically embodying what was in the resolution. He had always been an individualist. He believed in individual enterprise, and that neither State nor municipalities should interfere or meddle with enterprise. It was individual enterprise that made the country what it was, and the danger they ran at the present time was that State or municipal interference would unmake what had so satisfactorily been done up to the present time. What did they owe to the State and municipalities in the way of successful enterprise? Take some of the most important—steam, lighting, and water. When he was quite a boy he recollected hearing that a grandfather of his used always to go by water to London from Leith, and was once becalmed for 14 days opposite his own house on the Firth of Forth. Now they went against wind and tide and accomplished the voyage in 35 or 36 hours. Was that due to the municipality of Leith or even to that of London? No, but to private enterprise. Then again, take travelling by land. As late as his Oxford days he used to go from Edinburgh to London shut up in a state box on wheels, where he was kept for 48 hours, only getting an occasional outing of a quarter of an hour for meals. Now he got into the train at London at 2.30, and landed at his own home at 10.30, and could dine on board on the road. Did they owe that to the State or to the municipality, or absolutely to the unfettered liberty of private enterprise? You could go on in that way, and refer to all that steam had done in setting millions of hands at work in the cotton or other trades, but they did not owe it to the State or to the municipalities. Taking lighting again: going back to his youth they had tallow dips and snuffers. Now every little cottage had its paraffin lamp, and you had electricity in the streets and houses, and if the municipalities did not interfere the probability was that within a generation the electric light in many districts would be burnt even in cottages. So far from owing that to the State, all that the State had done with regard to

electricity was to stop it for a time. It stopped it completely in 1882, and a committee had to be called together to amend the Bill which had stopped electricity. Coming now to water: they heard a great deal about the water in London. He found no better water than he got in London, and always had an abundant supply. There was a great outcry on the part of the London County Council, who proposed if they were allowed by Parliament to spend £50,000,000 of money, and to rival the Manchester debt by bringing water from Wales. Why? Because through the waste by people in the eastern district, and because of this exceptional year there was a scarcity of water. He had an estate in Perthshire, and during the last summer every drop of water had to be carted. But he looked upon that as exceptional. He was not going to spend a lot of money in bringing water from the Grampians. By the Report of the Commission over which Lord Balfour presided, it appeared that the present water companies, with the little additions such as they could make, would find water enough for 12,000,000 of people for 40 years. Those who managed these things in London denounced the water companies as a monopoly, but it was not the State that brought the water to London, it was the companies which were denounced for making such profit as they were allowed to do under their Acts of Parliament. If it had not been for them they would now have been drinking Thames and Lea water flavoured with cats and dogs plus the sewage of 4,000,000 or 5,000,000 people. The other night he went to the Palace Theatre and saw a wonderful photographic exhibition, which included Lord Kitchener at Dover as he walked off the quay alongside the Mayor of that Borough. He thought to himself was it to the Mayor of Dover that they owed this and those wonderful photographs which showed all that passed, and other scientific developments, by means of which they could now really physically see through the human body? Was it to municipalities that they owed such strides and wonders as those? No. And if the State and municipalities did not step in and put a stop to all this sort of thing, invention was as yet in its infancy, its possibilities were endless, and the only thing which could stop it was municipal trading, by which as soon as a thing succeeded the municipality put out their hands and took possession of it. Science discovered and invented a thing, and then a few men formed a company and exploited it to make money for themselves in the first place, but no doubt what they were doing tended for the good of humanity. That was the way the world progressed, and must progress. Everything else was an absolute mistake. What was at the bottom of all this, more or less, was the wish to make the State and the municipality omnipotent, and to put the individual under the heel of the State. Last summer, some members of the St. James's Vestry, of which he was a member, thought it would be desirable, in the interests of the ratepayers, to establish an Association, and he got them to call it the St. James's Anti-Socialist Association: and there must be no mistake as to what socialism mea he drew up a manifesto, but being only just bo they thought that what he had written was too stro meat for babes; however he hoped it would not too strong for the digestion of such a body as he w now addressing. In that he pointed out that t whole tendency of socialism, as the German wri Lieberand in a book called "This Age of Our had remarked, was to make the State om potent; of course, the State embraced munici bodies. He said—and this was the key to all th socialistic questions—Socialism means "State om potence." Whenever a Bill was brought into Parl ment by which a municipality tried to take possessi of any enterprise, they had merely to put the test it, was it a step in the direction of State omnipotenc One point he put in the paper he referred to was thi "All this means State omnipotence, or a step towa it." That, he believed, would be the ultimate end this interference with private trade and enterprise. would be the most backward step which could taken. Major Flood-Page had written an admiral letter to the *Times*, in which he showed that at t present moment there were 70 Bills before Parl ment by municipalities, all of them trying to gra and make themselves manufacturers of everythi connected with electricity—and if with electrici why not with everything else? There was a mov ment now, and there had been a petition headed a member of Parliament, on the subject of bakeri It was proposed that all baking should be done the State. There was to be a complete syst of municipal bakeries for the whole of Lond for which it was said £10,000,000 would required, exclusive of the ground value and co pensation which would have to be paid for t disturbance of existing property. Supposing th gentlemen succeeded, there would be no priv bread-making, it would all be done by the municipali then the men would strike for higher wages, and t public would be starved out, because there would no means of getting bread. The only way to prev starvation would be for each person to keep a sup of sea biscuits, or peas and beans. Such a scheme that would be open to any amount of abuse in hands of those who were now pressing it forwa He would ask whether in the past the success municipal trading had been so great as to encouraging with regard to the future. He h that there ought to be a series of Parliament returns up to date which would give the debtor a creditor account of all the trading by municipalit in the United Kingdom. They knew that in t case of gas the Parliamentary returns showed that the great majority of cases private enterprise go great many more cubic feet of gas out of a ton of c than a corporation did, and his belief was that if th went through water undertakings or anything e they would probably find the same result. As to t ratepayer it cost him what was shown on the diagra

he had a double risk; he had the risk in the long of having to pay a great deal more, and he ›ped progress, or if progress went on and some ling concern were bought to-day by a municipality, an invention came out to-morrow which rendered bsolutely worthless, then all the debt was so much d weight on the unhappy ratepayers. A further ection was that it might be a fertile source of bery and of bribery, and the establishing of municil as opposed to market wages. If a man for his tion to the House of Commons gave a pot of beer was liable to a penalty, but if he brought Bill which took away the property of the few and e it to the many he became a popular candidate l was safe in his seat. If this went on the rateers would be saddled with a lot of things which uld be no use to them in the long run, and in contion with which there would be any amount of lversation and jobbery, besides the evils which uld come through the checking of enterprise. hat was the remedy? The remedy was a very ıple one if the people who had it in their hands uld exercise it. It all lay with the ratepayers. recently met the late chairman of the London unty Council, Dr. Collins, at a country house, l, in conversation with him after dinner, he said You want us to do nothing!" "Oh, no," he ›rd Wemyss) replied, "I beg your pardon, I nt you to do a great deal; I want you keep our closets and our drains in good work- order." On the strength of that, they became y friendly, and next day they visited a private ural history museum containing a large number interesting objects. In walking about this seum, he was very much struck by something one of the cases, and took Dr. Collins to see He said "This is the London ratepayer," l this object was a stuffed donkey! What its vious history was, whether it was a processional nkey or not he did not know; but there it was— absolutely perfect representation of that asinine ing, the London ratepayer, who submitted to being ;ed in every possible sort of way, with the results ich were shown in this donkey attitude, for he was the ground with his four legs doubled under him, dently crushed by the weight of municipal trading, d taxation, when he could very easily have thrown e whole burden off. That was a happy illustration what was coming. He did not believe the epayer would rouse himself. Some years ago, ey had a meeting in the Guildhall in Sir Joseph vory's time to establish the Ratepayers' Defence ssociation. It was established, and they had anches in some parts of London in 1893, some of ich he addressed. No, they did not care, and the ing had dropped. He was very much afraid they uld not trust to the ratepayers generally to be tive in their own defence. Another difficulty was at the question of taxation was not brought home those who governed, for they were governed now numbers, and by a system of compounding, the mass of working men did not know what rating was, and it was their power which supported this system of going in for trading and taxation. If that were done away with, and the working man knew what this legislation and taxation meant, he believed there would be a very different state of things. What could be done was only what was being done there, having able papers read and discussions upon them, which he hoped would lead, through the Press, to the formation of more instructed public opinions. But he also wanted something practical, such as was suggested by Major Page in his letter, that there should be a joint committee of both Houses of Parliament, to fix a limit which municipal trading should not pass. Two friends of his were once having a conversation, one of whom was a very unattractive-looking man, and his friend was speaking of how London houses were infested with bugs, and this gentleman said, "Oh, bugs never touch me;" to which his friend replied, "Oh, but even bugs must draw the line somewhere." He wanted a Royal Commission to draw a line across which the municipal trading bug should not pass. He held in his hand a paper from the London Chamber of Commerce, which recited in the first place what the Bills were to which he had alluded—that they authorised corporations "to manufacture, purchase, sell, or let meters, lamps, accumulators, dynamos, and other matters or things required for the purpose of the order, and to acquire, work, and use patent rights, &c." Could they have a greater blow to progress than that—the actual right to seize patent rights. Forty of the Bills before Parliament contained a clause to that effect, and yet they called themselves a free people. Then they went on to show that the Chamber of Commerce should petition against these Bills, and he hoped not only they, but every Chamber of Commerce in the kingdom would do the same, and the Society of Arts also; and that every trader who had a federation should not only, in the interest of himself and his trade, but also in the national interest, petition Parliament in the sense proposed in the resolution. After that, Government and Parliament would be obliged to stop and listen, not to the would-be municipal traders, but to the voice of reason, and in the future, as in the past, they must have progress as the result of freedom. He believed in liberty in all things—liberty to work for what hours, what wages, and for whom they liked, whether in the form of a Trades Union or not. He believed in liberty of trading. He resigned his seat for Gloucestershire in 1846 rather than vote against Corn Laws. He believed in private enterprise, not in State interference, or in the State making contracts for men. The contracts made for the State were always made in the interests of the many, as against justice for the few. That was his experience of Parliament in its working. He had struggled for liberty all his life. He had not long to live now, but what time and health he had he would still give to this purpose believing that liberty was the only thing worth living

for. It was that which had made the nation and State, and municipal inroads on liberty would unmake it. He hoped when he passed away his epitaph would be—"He loved liberty."

Mr. JOHN BURNS, M.P., said the noble lord, with characteristic rashness and demagogic irrelevance, had departed from the subject of the paper read at the last meeting, and had embarked upon a series of observations about the growth of socialism and the danger which would accrue both to the people and the nation if municipal socialism was not retarded. He would venture not to follow the noble lord into the narrow paths and bye-ways through which he had diverged, and which otherwise might have been an interesting subject of discussion. He intended to deal with the paper which had been read, and incidentally to take one or two of the noble lord's arguments. Much which he had said was inappropriate and generally speaking was archaic, where it was not absolutely worthless. For instance, Lord Wemyss said—what did we owe to the State? He would like him to put that question to the House of Lords to-morrow morning in secret session, and he would be told by his fellow Peers that the State had given them that power which they undoubtedly exercised; it had given to the class he belonged a great deal and it was because the State had been used by a class unjustly for the expropriation of the people as a whole in the interests of a section of the classes, that the community as a whole wanted to resume possession of that instrument of State, in order to do for the nation what it had hitherto done for a privileged few. The noble lord said what had the State done for steam? That had as much bearing on the present debate as if he were to ask how much wages the carpenters got for building Noah's Ark, and, with regard to electricity, the same argument applied. Then he came to water and said he was satisfied with the London water supply. The firemen in the Minories that day were not, and the people in the East-end of London had been considerably disappointed with the London water supply. The noble lord said they wasted it. That was an *ex parte* statement, probably coming from a director or shareholder, and it came with peculiar bad grace from the representative of a class who taunted them with being the great unwashed, and would not give them water to make them clean. He did not see that the defence of the London water supply as it existed helped Lord Wemyss much, and if that was the only argument he could bring against the municipalisation of water supply he was in poor straits. He would suggest to him that if what he said as to the results of municipalisation were true it was an indictment against the common sense of the most practical people on the whole face of this earth. He said we were rapidly going to dissolution because municipalities were assuming duties which should be left to the individual. He ought to know that the answer to that was that those eminently practical British people had in the course of the la two centuries taken from private enterprise 800 watc works in England, Scotland, Ireland, and Wale beginning with the Plymouth Municipal Waterwork in the time of Sir Francis Drake, and not in o instance had they abandoned municipal water supp and reverted to private enterprise. The fact th they had held on to a municipal supply was eviden that the British people believed that if it was right help monopolies for the benefit of a few individuals was doubly welcome and beneficial when its adva tages accrued to the whole community to use th power. He asked what had the State done? H ought to know they were indebted to the State f life, liberty, and property. They were indebted to it f national defence, and if the exigencies of nation defence compelled men to submit to co-operati effort, and by cohesion to do what would be futi if attempted by an individual—if it was right f destruction it was right for production and any i dustry which that community cared to undertak The noble lord said the time had arrived whe the people should band themselves against th exaction by municipalities. What were the facts Whether a man were a Conservative, a Libera a Radical, or a socialist in political life, he foun that the necessities of modern life, modern i dustrialism, municipal institutions, and nation interest compelled either the municipality or th State to resist monopolies in abusing their powers an in carrying the power of capital too far. Socialis was called into existence less by an instinctive desi for socialism as a theory than to use it as a matter defence forced upon the community as a last resour against the exaction of private enterprise, and th tyranny of monopoly pushed too far. If Lord Wemys feared the growth of socialism, as he did, it syn chronised with, and was proportionate to the way i which the gains of industry and monopolies ha called socialism into existence, by the way in whic they had pushed the tyranny of private property to far. There were 800 waterworks, 250 gasworks, 5 tramways, 100 electric lighting systems, 12 dock and so forth under municipal control, with the resu that the capital value of the property owned by th different municipalities in Great Britain was equal t £500,000,000. He was not frightened by diagram It was said that figures never lied: that was true but liars sometimes figured. The people through the local authorities had £500,000,000 worth of capit property for which they had contracted loans £250,000,000, as the diagram indicated, but not a wo was said about the assets and remunerative property hand. When he came to an analysis of the objections municipal enterprise, he found it was not against th loans as a means of securing better assets, but it w simply the dividend hunter deploring the profi going to all instead of to a few. He sa the other evening that Sir Richard Webster talke about municipal enterprise creating a fictitio rate of wages. It had done no such thing, an

was only the uninformed who made that legation. He might take the London County ouncil as an instance, as he happened to be the ıthor of that very much debated trade union clause. /hat did it consist of? The London County ouncil (and 300 local authorities had followed its ample)—bad news for Lord Wemyss, but excellent r the community and the workmen, though bad for e contractors who made the Embankment—adopted is regulation: "The rates of wages and hours of bour recognised by and in practice obtained by sociations of employers and trade unions of workıen." What a revolutionary document! What a ıost mischievous doctrine that the rate of wages in ractice obtained and agreed on by associations of mployers and workmen should be subject to so ıuch impotent and frenzied discussion on behalf f the noble lord and his supporters! He saw alleged in the paper that a great deal of maldministration was due to the spirit of municipal nterprise which prevailed. As one who had been to America—and the noble lord would probably approve f much that he said in the teeth of the American eople about the way in which greed, jobbery, and naladministration were rampant, he might tell him hat neither he nor the reader of the paper could ut down to socialism or municipal enterprise anyhing like the jobbery and maladministration that here prevailed. Maladministration existed in America simply because of private enterprise, and ecause millionaires bribed judges, squeezed senators, nd purchased legislators? What for? In the inerests of the community? No, but to extend he tyrannical influence of private property still urther—to get contracts, to make money—and in o doing they were debauching the community nd demoralising the State. Wherever you saw nunicipal enterprise undertaken in America, either in water, electric light, or tramways, there you had the beginning of good government, and it was from municipal enterprise and to its success in England and the absence of jobbery and generally of pure administration, that the Americans were following our example, and were beginning to set the crooked paths straight. When the reader of the paper attributed to the State and municipalities the defects which were patent to any observer in America, he was very far from the mark, and was certainly not speaking from actual experience as everyone could affirm.

Mr. DAVIES said he quoted his authorities; he did not speak from his own observations, but from American observers, who reported from their experience in America.

Mr. JOHN BURNS said his advice to Mr. Davies was to abandon those authorities henceforth, to throw those political Jonahs overboard, and make a trip to America himself, when he would come to the conclusion that every competent observer in America had come to. Then, the noble lord asked if municipal trading would pay. Was it likely that Scotch Conservative aldermen in the City of Glasgow, retired captains of industry, would be in favour of municipal enterprise unless it did pay? The answer to that was that there municipal enterprise gave 50 or 60 gallons of better water per head to citizens for 6d., but London people had a worse quality and less of it for 1s. 2d. With regard to gas, Lord Wemyss ought to know, as every engineer did, the number of 1,000 cubic feet produced by a ton of coal; although it varied, it was all over the country practically about the same, and where the municipalities produced a rather less quantity they did it because they preferred a better quality and higher candle-power than the average private companies did. Where that did not prevail it was on account of better wages, shorter hours, and fewer accidents than the private gas-holding shareholders could show in London that the difference between the company and municipal systems was accounted for. The noble lord said the time had arrived when the ratepayers should be aroused, and with the next breath he doubted if it could be aroused, because he knew, as well as anyone, that they could not arouse the ratepayer in London, or anywhere else where any public policy was beneficial to his interest, and they would only regret municipal enterprises when they ceased to be profitable. He was one of those socialists who believed in making municipal enterprise pay wherever it could, and he was not afraid of comparison. To hear the noble earl speak, one would think that the 800 waterworks had been taken from their private owners by force of arms, but he saw that every one of them had been compensated, not only up to the market value, but over the market value. He knew full well that whenever, in any instance, where the State or municipality had superseded private owners in this country, no harm had been done to the people who had been dispossessed. Take the case of the tramways. The London County Council paid them £800,000 for plant which really was not worth more than £500,000. The company got what the House of Lords itself declared to be not only a full price, but a generous price, and, in every case where compensation had been awarded, no one had been despoiled. It was said the House of Commons had a great duty passed upon it to throw out these 70 Bills. The House of Commons would do no such thing; the House of Lords might attempt it. He presumed the noble earl wanted an inquiry to put an end to municipal enterprise, but he could assure himself of this fact, that the House of Commons had ceased to be a chapel-of-ease to the London Stock Exchange, and the House of Lords would cease to be some day an appanage of the big landlords of this country. Slowly, but surely, the people were coming by their own. They were using the local authority as an instrument of spreading over the many what monopoly had hitherto given to the few, and they would carry that some day to the extinction

of the House of Lords, of which the noble earl was so distinguished a member, and would sweep it away, because it represented nothing but property—nothing but mere money. Hitherto the function of the State had been used for robbing the people, and it was because the people wanted the State to be the protector and defender of the people that municipal socialism was gaining ground. The noble earl was a mere Dame Partington with a broom trying to rush back an ocean which was now at his feet, and if he did not mind it would soon be up to his neck, but in the interests of liberty he trusted it would not drown him.

Lord WEMYSS said he should like to ask Mr. Burns whether it was his view that all private property, what he called the instruments of production, should be in the hands of the State or the municipality?

Mr. BURNS—Yes.

Mr. DUNDAS PILLANS said he felt sure that very seldom within that hall had a speech, similar to that which they had just listened to, been delivered; an admirable speech of its kind, and most valuable to those who took the opposite view, because it disclosed, in all its naked hideousness, the policy the speaker had persuaded the people of this country to adopt. It was a speech, however, inappropriate to the occasion; it should have been delivered either in Trafalgar-square or under the Reformer's Tree in Hyde-park. They were there for the purpose of following up the debate so ably opened last week, and to discuss a matter which, however much their opinions might differ, they would all agree was of the greatest public importance. It was a matter which did not only affect one class of the community, but everyone, and the poorer classes to a greater extent than the richer, because any municipal expenditure must ultimately press heaviest on those who had least money to spend. He would attempt to bring back the debate to commonsense, and to avoid flights of rhetoric. It seemed to him the subject presented itself from two different points of view. In the first place it might be considered from the purely business standpoint. Could enterprises involving profit-earning be conducted as profitably and economically under Government administration as under private control. He had had considerable knowledge of various forms of business administration, which might be divided into three classes; first, business under exclusively private control; second, those conducted by joint stock companies; and third, those conducted by municipalities or the Government, and he submitted that those three forms represented three degrees of efficiency and economy. Where personal supervision directed a business you had the greatest efficiency and success. It was notorious that the master's eye had a great effect in obtaining the utmost possible work with the least degree of expenditure, and, therefore, you frequently found businesses which prospered under private control when co verted into joint stock companies showed a falli off in profit and not unfrequently reached a sta when a liquidator took them in hand. Why was thi Because, after all, success in business depended on se interest, that was the only sound principle on whi business could be conducted. It was manifest that wi company organisation the motive of self-intere was distinctly weakened; the officials had not t same personal interest in the concern as if they we the owners. They had some interest, becau if the company were not a success they would n receive their salaries. But when they went furth and placed the business under municipal or Sta control the motive of self-interest became eliminat to such a degree that it might be put out of t question; whether the business succeeded or not t salaries would be paid because they had the purse Fortunatus to fall back upon; the wretched ratepay would be called upon to pay whether the business we successful or not. In the case of a company it woul be wound up, but in the case of a municipality State the salaries would continue to be pai Therefore, on the face of it, it was fairly arguabl that an organisation under State or municipal contr was the most wasteful, extravagant, and least succes ful of any, and they knew from experience tha that was so. It had been discovered in the buil ing of ships that the Government got much bett value for their money if they put those enormou contracts into the hands of private traders in stead of building them in State dockyards. As member of the municipality of Richmond in th neighbourhood of London, first as a Councillor an afterwards as an Alderman, he found the greates extravagance was to be feared where a business wa organised under the control of a small locality, becaus there you had certain circumstances which tended t increase the danger of corrupt administration. Ther was always the tendency of town councils to indulg in experiments at the expense of the ratepayers. Th town councillors all knew each other; they wer companions and friends, and there was always tendency to play into each other's hands. On great point which came under his notice was tha there was a principle adopted in giving contracts fo work under the town council to keep the business i the locality; a sort of spirit of local patriotism existed and there was a tendency on the part of members without any intention of corruption or jobbery, to give contracts to their friends, and to keep the business in the locality. This tended to extravagance because it was manifest the wider the area of contracts and tenders the greater must be the efficiency and economy. They were often told that places like Glasgow were very successful in administering waterworks, tramways, and so on, but there was no guarantee that in drawing up their balance-sheets any allowance was made for depreciation of plant, and he was not aware whether, in Glasgow, they had debited against their income an equivalent for the rates which would be

ed in the event of the tramways being under pri- enterprise. There was no audit corresponding to udit which company's affairs were subjected to for ourpose of laying them before shareholders' meet- When they were told about the wonderful ts which the Glasgow tramways claimed to have , it was almost incredible that it could be true. as alleged that they had not only reduced the s of labour and increased the wages, but they had eased the profits. Before these statements were pted, they ought, as business men, to be satisfied they had debited against their income all those ters which would have been debited if it had been ivate concern. Then, coming to the other branch he subject, and considering it from the ethical it of view, the evils that municipal trading had wn were very much more serious. Mr. John ns had asserted that eight hundred waterworks been taken over by municipalities, and that they all been managed without the slightest corrup- , and with due regard to the welfare of the rict.

Mr. JOHN BURNS said he did not say so, but it s a curious fact that no corruption had yet been ved.

Mr. DUNDAS PILLANS said they must not only e into consideration the actual facts, but also ure probabilities, and they knew that within ent periods there had been disclosures with gard to the Works Department of the Lon- n County Council which had thrown consider- e suspicion on that illustrious body. When a w idea was first put into action the greatest amount public interest centred in the experiment, and was only in the nature of things probable that those anaging the concern would be exceedingly careful at they were about. But as time went on, he feared at public interest would be considerably diminished, d by degrees it would be found, as it was always und, that abuses crept into public departments. One eat danger was that the employees of a municipality ere also voters, and there was a tendency on the rt of a representative to make things pleasant for ose who elected them. If they could tell the eople that they had been able to raise their wages, d to shorten their hours, there was a great mptation on the part of representatives to do these ings, forgetting that they were not there for the urpose of paying fancy prices to labourers, but as ustees of the public to administer public funds, and conduct the business entrusted to them precisely the same way as they would if they were private ersons employing these same people. He recol- cted during a recent election for the London County ouncil, in going through the borough of Southwark, eeing on the hoardings posters appealing to the lectors to vote for so and so, who would pay the cavengers a minimum wage of 25s. a week. That was serious element of corruption and a source of danger which thinking men would do all they could to guard against. There was a theory now abroad that by the direct employment of labour they could save the profits of the contractors and obtain them for the community. He believed that to be a great delusion. The contractor was a man who knew what he was about; he understood his business and knew how to obtain the maximum of labour from the men under him. It is all very well to flatter the working-classes and tell them the State was going to restore to them what they had been deprived of. That would do for the Reformers' Tree, but was not suitable to an intelligent audience. It would be much better to tell the working man that he had no more claim to consideration by the municipality with regard to wages or hours of labour than any other class of the community. The contractor had no such sentimental influences at work. He appointed a foreman who would get the utmost possible work out of the men, as it was only right he should. The British working man was a very good fellow, but he needed a lot of looking after. They found the greatest difficulty at Richmond to persuade the British workman to do a fair day's work for more than a fair day's wage. It was a very difficult thing, in view of the omnipotence of the ballot-box, to get any foreman to properly superintend work, and make the men do an honest day's work. As soon as their foreman tried to do what a contractor's foreman would have done, the men immediately came before the Surveyor's Committee, and held him up to execration as an oppressor of the poor. He himself had been taken in like that several times. He used to boil over with indignation at the treatment received by the labourer at the hands of the tyrannical foreman, until he learnt better by experience. The consequence was that jobs lasted twice as long as under a contractor, were worse done, and cost a great deal more. It was very undesirable to increase the power of a bureaucracy as he knew through having lived for some years on the Continent, especially in Italy. There was no greater danger to the community than that it should be over- ridden by bureaucrats. There was no more objection- able person then a man who got into a uniform, and swaggered about lording it over his fellow creatures, and he wanted to prevent the progress of that sort of thing in this country. They owed their greatness mainly to the spirit of independence and individualism which was characteristic of the English character, and he trusted they would adhere to that faith. That had made the country great, and that only could keep it great in the future.

Mr. C. FAIRFIELD said interesting as was Lord Wemyss's address, his most important recommendation was the practical one that they should try to get the Government to hold an inquiry into this matter. Most contradictory statements were made as to the profits of municipal experiments, and Mr. Burns's speech showed the absolute necessity of getting the facts and figures. There was a formidable table on

the wall which showed £250,000,000 of municipal debt for the most part piled up within the last few years, half of it admittedly spent for "sanitation" which could return no direct profit to ratepayers. They wanted to know about the other half. It was expenditure which had grown so much of late years since a wave of socialism had come over the House of Commons. Mr. Burns said there was £500,000,000 of assets to put against that, and they wanted to know if there was any truth in his assertion, or whether a great portion, consisting of waste material, enterprises which had since become obsolete, with which the ratepayers were now saddled, did not represent a net loss. They also wanted to know the facts about the Glasgow tramways and other schemes there; was it really true that the private company which had been superseded paid £30,000 a-year rent — all thrown away when the tramways were municipalised? Lord Wemyss, who was an Individualist, was not in the habit of running to Parliament for protection, but in this case Parliament was responsible for the evil of which they complained. Mr. Balfour's answer was that ratepayers had the remedy in their own hands. That was true in small areas, and to a certain extent, but the growth of modern cities had altered the whole phenomena of local self-government. The ratepayer to-day was powerless, he was a helpless unit, it was so in London and in New York, and Mr. Burns must know from his journey to America that it was only in the large cities that municipal corruption was rife, and that malpractices prevailed. In the small municipalities administration was pure. He had lived five years in the West in cities of 2,000 or 3,000 inhabitants, where the ratepayers could take an active interest in local matters, and the administration there was pure and businesslike. The success of local government was in inverse ratio to the size of populations. What did the people of Manchester know about the agenda paper which came before the City Council every day? The men who had to deal with it ought to have a salary of £1,000 a year each, but these gentlemen were busy professional or business men, and the result was that proposals to municipalise everything fell into the hands of committees, and were carried without the knowledge of the ratepayers. That was why they asked for a Parliamentary inquiry. Assertions that municipal socialism paid came from Mr. Burns and a small section who thought with him, but the great majority who had been active in advocating municipal socialism did not take the trouble to declare that the thing paid on its merits. They said it ought to be based on higher considerations than £ s. d.; that the promotion of great ethical, moral, reforms was a justification for schemes which ignored ordinary business principles. Mr. Burns asserted that they paid, but he should prefer to see a balance-sheet. Many "municipalisers" boldly asserted that the scheme they advocated did not pay, and ought not to pay. They were benevolent, philanthropic people, who said it was their duty to give good wages to working man, to make his life better, and his hor brighter, more purple-tinted than it was be All that sort of thing could not pay. Apart the question of debt, there was the question of growth of municipal bureaucracy, which was a ter danger in this country. The Government had alr called into existence an enormous State bureauc in the shape of school-teachers, virtually sala State officials, banded together in a trade un whose main principle was self-interest—raising salaries and increasing the privileges of its memb Added to that, there was the approaching threate bureaucracy to administer an enormous mass the ratepayers' money, which would be a formidable political danger. That munic bureaucracy already had a trade union, and t claimed for themselves not the right to compete v private traders, because they did not want to co pete—Lord Farrer once, in a moment of econo remorse, challenged the London County Council compete with the contractors by doing work outside bodies—they did not want to compete, t wanted a monopoly. Most of these corporat officials were able and energetic men, very proba some of the most respectable men in the kingdo but still there was a terrible temptation to jobb of various kinds, and, as this was increasing ev day, he thought it was high time that Parliam should inquire into the matter.

Mr. PERCY SELLON said as he read the paper he d not consider it was an indictment of municipalisati as such. The average man took the view quite righ that it was too late to attack the whole principle municipalisation. He certainly held that it h thoroughly justified itself with regard to cert classes of commodities, and that it was good f society at large that these commodities should provided by the municipality and not by private ent prise. On the other hand he believed the avera man held, and probably even Mr. Burns would agr so far, that there were certain classes of commoditi which carried with them big trade risks which t municipalities ought not to take in hand, because th were not so well qualified to do so as private ente prise. Between those two extremes there were certain number of cases with regard to which men both schools held sincere and diverging views. A he understood the paper it amounted to this: th with regard to the particular matter of the electric industry, which was the one in respect of which th municipalising question had chiefly arisen in the la 20 years, municipalities had not given so goo an account of their stewardship as private ente prise would have done. Now was it possible t make out a *bonâ fide* case before competent judge whether the municipalities had in fact conducte electrical enterprises worse than private bodies. I such a case could be made, the question was wha was the proper remedy. There was one point whic

d not yet been alluded to, namely, the light which e experience of foreign countries threw on the atter. He had had exceptional opportunities of eing and hearing what was going on in America, Germany, and in Switzerland, and he believed it as beyond dispute that in those countries electrical ience was far more highly developed in the interests the public than in this country, and, secondly, that those countries it had not been handled chiefly by unicipalities. In America, out of 2,589 electrical nterprises, 2,250 were private, and only 330 muni-pal; but in this country there was a majority of ocal authorities. If these figures had any significance, e deduction was that electrical enterprise had moved elatively slowly here because it was in the hands f municipalities. Those who held the view put orward in the paper were of opinion that the sugges-on made by Lord Wemyss was a practical one—at Parliament should be asked to appoint a com-ission of inquiry. It was not a matter in which here need be any antagonism of interest. The muni-ipality represented the ratepayers, and the ratepayers ere the public. They wanted to know whether heir money should be taken from them in rates or hether they should be allowed to invest their money reely in industrial affairs. Therefore the interest of he local authorities, and the interests of those who eld the private enterprise view were identical, and hey might well join hands in presenting a joint etition to the two Houses of Parliament asking for his important commission.

Mr. SPENCER HAWES said he hoped to have been ble to deal with several points raised in the paper nd the discussion, and to have had the opportunity f showing how municipal enterprise in relation to lectric lighting had given vastly superior results to hose attained by company operations, but time did ot allow him to do so fully. He would, therefore nly take the point Mr. Sellon had referred to, that ocal authorities had not given so good an account f their stewardship as companies had. That view e held was entirely opposed to the facts. Local uthorities indeed were giving consumers a cheaper upply, and were carrying on their undertakings at a ower cost than companies. Taking first the average rice charged to the private consumers of 39 com-panies whose accounts had been filed, it would be found that no less than 15 per cent. showed an average price of between 7d. and 8d. per unit. On the other hand there was not a single local authority n the kingdom which charged so high a price; 28 per cent. of the companies charged between 5d. and 6d., as against 4d. per unit in the cases of 60 local authorities. Only 21 per cent. of the companies charged under 5d. per unit, the lowest charge by a company undertaking was 4·06d. per unit; but you had 52 per cent. of local authority undertakings charging lower than 5d., the lowest price being $3\frac{1}{2}$d., charged by the Edinburgh Corporation. There were seven local authorities charging less than 4d. From the arguments that had been adduced that evening, it would appear that a board of directors alone possessed the necessary qualifications for the proper administration of electric supply undertakings. The practical control of all these works was in the hands of the administrative officers and officials, and under the local authorities there were as capable and clever engineers as in any of the private under-takings. Let them take the working expenses, ex-clusive of interest, sinking fund, or depreciation charges, and they would find that of the 39 companies referred to, 26 per cent. had produced their outputs at a cost of over 4d. per unit, whilst amongst local authorities, only 8 per cent. of the 60 had to record similar costs. There were only 5 per cent. of the companies, whose total costs were lower than 2d., and of the local authorities there were over 25 per cent., and in one case they were down nearly to one penny. Replying to a question, he said that the profits being determined by the rate of charge to the consumers, the gross amount of profits was not a clear indication of the success or otherwise of any undertaking. The Brighton Corporation, for instance, in 1897, made a surplus profit of £2,800 only because its charges for electricity to private consumers were as low as $3\frac{3}{4}$d. per unit. A company undertaking of similar size—Chelsea—had to its credit a net surplus of £9,800; but it had charged its consumers $5\frac{3}{4}$d. per unit. Had its charges been as low as those at Brighton it would have had only £1,000 for distribu-tion to its shareholders.

Mr. E. GARCKE said this subject was very large, and he would endeavour to refer to one or two new points; but first he must say a word on the statements made by the last speaker, which, he ventured to say, were entirely erroneous. He had referred to a lower price for electricity being charged by corporations, and to a lower cost of working; but taking the cost first, he had ignored altogether that the corporations omitted from their accounts items which had to be incurred by companies, and ought to be charged. The corporations managed to charge the services of the town clerk, the borough surveyor, and many other items to other accounts. Then with regard to the price charged, the local authorities had the question of public lighting in their own hand, and they adjusted that according to the needs of the accounts. With regard to profits, he had made a most egregrious blunder, and it was the statement which Mr. Burns made that was at the bottom of the whole question. He stated that it was not the object of local authorities to make a profit, but Mr. Burns simply said the object and policy of the corporation was to make a profit; therefore it was an important question for Parliament to determine not only what was to be the scope of municipal enterprise, but the principle on which it was to be conducted: were the local authorities to make a profit or not. He had lately had occasion to analyse the net result of the working of electrical supply undertakings by corpora-

tions, and he found that although a profit of about half a million was made by all the municipal corporations carrying out electrical lighting, they had taken more from the rates during that period than they had returned to the ratepayers. Then where did the benefit to the ratepayers come in? He endorsed the practical suggestion that every effort should be made to obtain reliable facts upon this important question. They were all ratepayers, and were anxious to learn, and he was quite sure that Mr. Burns, nothwithstanding the recklessness of some of his statements, would be very glad to be corrected if he was wrong. A practical social revolution of the industrial conditions of this country should not be allowed to take effect without careful consideration by Parliament, and it should not come about by various private Bills promoted by this or that municipality, but should be determined after careful consideration. He therefore endorsed the suggestion that the Society should petition Parliament, as it had done on former occasions, for the appointment of a Commission; and, further, that the excellent paper of Mr. Davies should be reprinted for general circulation. One thing which had come out was the enormous complexity of the question, and the apparent want of knowledge of its complexity. He had always found the majority of people took very little interest in it, and therefore the more they could disseminate sound literature upon the subject the better. One point which had occurred to him was the danger of extension of municipal enterprise arising from the want of efficient management. He did not question that efficiency at present, though it might be open to doubt, but he would ask, if this tendency were to go on, who was going to do the work of the municipality? At present a few gentlemen who were enthusiastic for the welfare of the community devoted themselves to this work; but if the London County Council undertook not only electric lighting, but tramways, electric traction, and all other industrial enterprises, who was going to do the work? Was it fair to say that a human being, whenever he is acting as a private individual is greedy and self-seeking, but the moment he joins a Town Council he becomes no longer self-seeking, but is entirely devoted to the welfare of the public. It was not fair to put upon any individual the huge amount of work it was proposed to put upon Town Councillors and not remunerate them; but if you did, it would introduce an entirely new factor to the question. Then you had to consider whether it was better to carry on these enterprises by means of self-interested public companies, or whether they should have the State or the municipality-employed officers. Again, if the municipal corporations were going to be authorised to do this large amount of work, they ought to be put under the same restriction and responsibility with regard to the rendering of accounts. There was no other spending body in the State which was not called upon to render accounts. Why were not the municipal accounts published in the same unifor manner as the Board of Trade required tramw companies, gas companies, and electric light cor panies to pnblish their accounts? It would be sai no doubt, that the accounts were published, but th were published in such a manner that they nev knew whether it was the electric department whi paid or some other. Another important questi was the difficulty of securing continuity of polic During many years he had had to carry on negoti tions with local authorities, and the difficulty always experienced was this—he would attend o Council meeting, when the question would be di cussed, and a gentleman of great eloquence wou get up and make a speech, which carried the who Council with him, and for the time the matter w disposed of, but the next meeting, when that poli was to be continued, that gentleman was not ther and somebody else got up of equal eloquence on t other side, and the whole policy was reversed. Th was not a business-like way of carrying on busine undertakings. He did not think there was any great danger threatening the development of industry th the careless indefinite way in which this question w dealt with. It ought to be defined one way or t other. If these things were to be carried on b corporations, let the public know that they woul have to put their savings into corporation stock and become corporation officers, or else to leav the country with their capital and energies and g elsewhere.

Major FLOOD-PAGE said he wished to enforce t suggestion that the Society of Arts should petitio Parliament, in favour of the Joint Committee, an he spoke as a member of the Council of th London Chamber of Commerce, where the ques tion originated from the fact that seventy mun cipalities were making an attack this session o the electrical industry, asking for powers to manu facture lamps and other things. This was a matte vital to the trade and commercial interests of th country, and they were in communication with ever Chamber of Commerce in the kingdom, and h believed there was none which would not suppo the petition they had originated. Electricity wa as yet in its infancy, but, according to Mr. Garck who was a great authority on all statistical matte in connection with it, about £100,000,000 of mone had been spent in electricity. Going back to th time when Lord Wemyss, as he has told us, gave u his seat in Parliament in 1846, railways were then i their infancy, but they have spent £1,000,000,00 Who had spent it, private enterprise or the munici palities? Why were they behind every other countr in the world in electricity? Simply because Parliamen had put them under the local authorities. There were n less than 104 municipalities which had the power t introduce electricity, but had not done so and kep everybody else from doing it. There were now number of companies asking Parliament for power

take cheap electricity all over the North of England, but the municipalities were up in arms, and wished to prevent their interfering with their monopoly. In Liverpool there were 700,000 people, 000 only of whom took the electric light, but we want that every man should have the electric light as he had water, and this could only be accomplished if the obstruction of municipal trading was put an end to.

The CHAIRMAN said he must now bring the meeting to a close in the usual way of proposing a hearty vote of thanks to the reader of the paper. Whether they agreed with his opinons or not they would all join in thanking him for it, and it was not only valuable in itself, but it had, he hoped, evoked a very valuable discussion though it was true the fringe only of the subject had been touched. With regard to the request which had been made, that the Society of Arts should petition her Majesty's Government to institute an inquiry into the whole question of municipal enterprise, he should have pleasure in submitting the wishes of the meeting to the Council of the Society of Arts, but if he might venture to make a suggestion, he thought a very happy sequel to the proceedings would be if Mr. John Burns would add to their indebtedness to him for taking part in the discussion by moving from his seat in Parliament for the inquiry which was so eagerly sought for. He was quite sure that he was as anxious to get at the facts as anybody else, and would support any petition the Society might make in the direction suggested.

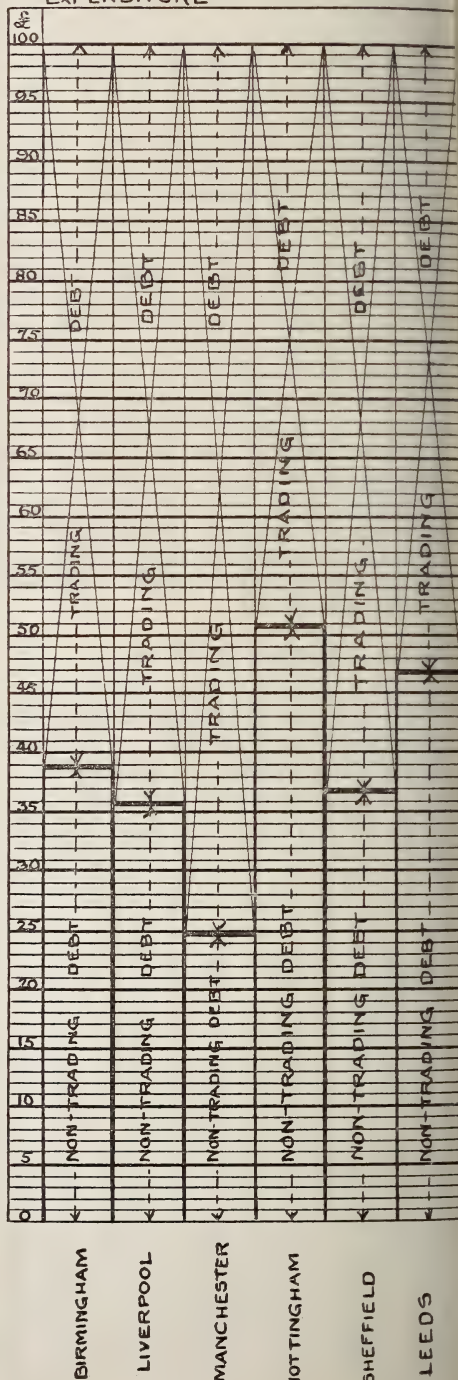
The vote of thanks having been carried,

Mr. DAVIES, in reply, said his thanks were due to the audience, and especially to the Council of the Society for giving him the opportunity of discussing this exceedingly interesting though somewhat complex scientific question; they were also due to the Attorney-General who was so gracious as to take the chair when the paper was read, and also to those who had joined in the discussion. He might say he was specially indebted to Mr. Burns for having been so courageous as to come forward in an almost entirely hostile audience to put, with perfect candour and frankness, his view of the matter. The subject was not a new one to him, as he had been engaged in a professional capacity in fighting a kindred question, namely, the right of private traders to come and push their electric wires into the boroughs in the North of England. In that effort he had been met with a unanimity of malignant opposition on the part of the officials of municipalism, which had been startling. The subject had been a subtle and difficult one, which could not be dealt with in a few paragraphs in a newspaper, nor could it be dealt with at a scrappy meeting of one or two ratepayers who might get together and sanction opposition to a private Bill. It could only be dealt with in any sort of rational manner when a scientific society like that gave both sides a full opportunity of expressing their views. The Council had been so good as to accede to his request and especially invite the town clerks of those corporations who were opposing this important commercial innovation, and as he was anxious they should know exactly what his views were, his paper was distributed amongst them beforehand; but he must confess that his gratification at the proceedings which had taken place was tinged by a drop of bitterness inasmuch as he had not had one of those honourable opponents there to say one word in answer to his reasoned justification of the attitude he had ventured to take up. Might they not assume from this silence that these experienced and learned upholders of municipal institutions were in their hearts as convinced as he was that municipal trading was prejudicial to the best interests of the corporations. There had been some admirable contributions to the discussion, most of which struck the note of liberty, and he was glad that that was followed by Lord Wemyss in his peroration, when he told them that he should like to have written as his epitaph that he loved liberty. That epitaph might be written—he hoped it would be a long time first—equally well on the grave of Mr. John Burns. The question was, not whether they loved liberty, because they all loved liberty, but by what method would liberty be best assured to our citizens. Would it be assured by absorbing into the embrace of municipal government every activity and industry, or would it be better accomplished by leaving activity and energy free to trade in the old way. He honoured those who held the socialistic view and frankly stated it, but he hated the man who called himself a municipalising radical, or democratic conservative, or some such misleading name. He wanted all those disguises thrown off and the principles at stake freely stated. No doubt Mr. Burns reflected the feelings of a great many of the working-class, that the method of wealth production had hitherto been absorbed by the propertied class. It might be that certain methods of wealth production had in the past been so absorbed, and that the power of the State had been used to protect that absorption. But the methods of wealth production, of which he had been advocating the freedom, namely, the brains and activity of the people, were not capable of being enslaved or owned by means of any property title whatever. The real activities he wished to see freed the most, existed not in the ownership of so many miles of copper wire, or of railway track, but in the brains and energies of the people themselves. It was impossible those brains and energies could operate to their full capacity for the advancement and advantage of society except in a medium of entire liberty and independence. Mr. Burns said that if the discipline of militarism was good for the organisation of methods of defence and attack, was it not equally good for industry? It was not. The same systems of discipline and methods of organisation which might be all very well for military purposes were not adaptable to industrial developments. With regard to the limit which should be drawn to define the boundaries of the

functions of the local governments, it seemed to him that if you went back to the principle of democracy, you got the true line. That principle rested on no assumption that the many were wiser than the few, or the poor wiser than the rich, but on the single law—the result of experience—that a man could be trusted to attend to his own interests, and not to anybody else's. Therefore each man, as he had an equal interest, whether poor or rich, in the defence of the country, was entitled to an equal voice in the appointment of the Government, but it followed from that that the Government should confine itself to matters which were of common interest to everybody, and the Government or municipality should not engage in matters which were of interest only to a small proportion of the community over which they were appointed to rule.

Mr. Davies writes :—Owing to the late hour of the evening to which the discussion was prolonged, the writer did not feel himself permitted to enter upon statistical points in his reply. He would not, however, like those who honoured him by examining his Tables to think him neglectful of their criticisms. The supplementary Table (No. 6) has been compiled to meet the suggestion of Sir Richard Webster. The figures in this are taken from the last edition of the "Official Intelligence" and show the proportion of outstanding indebtedness of the typical towns which is attributable to remunerative, that is, presumably, trading expenditure. This proportion varies it will be seen from 75 per cent. of the whole debt in the case of Manchester to nearly 50 per cent. in the case of Nottingham. How far, if at all, the outlay of these large sums has relieved the burden of the ratepayers it is very difficult to ascertain. Owing to the complexity and lack of uniformity in the accounts of the different corporations, and in the system of valuation, to say nothing of the disturbing element of large corporate property, the revenues of which are applied in the relief of the rates in some towns—(the Corporation of Liverpool, for instance, is a large owner of landed property in the very heart of the city)—it is impossible to compare the rates levied in one town with those in another. All that can be said is that the rates in the six towns mentioned are high. The amount collected in Manchester last year was, according to the last edition of the Municipal Year Book, 7s. $1\frac{4}{5}$d. in the £, in Liverpool it is 6s. $0\frac{1}{2}$d., in Sheffield it is 7s. $11\frac{1}{2}$d., in Leeds 7s. 2d., and in Nottingham 6s. $11\frac{1}{2}$d. In regard to Mr. John Burns' statement that the assets are neglected in the Tables, this is hardly correct. The assets (as stated in the paper) are duly reflected in the statistics of rateable value, for of course the justification for the outlay of ratepayers' money in the making of roads or the laying of pipes and wires up to his property, and the supply through those pipes and wires of various commodities which he has need of is the amenities which those works have added to his property. These amenities are duly taken note of when the valuation list[s] [are] revised, and the point remains that the indebtedn[ess] and also the rates in the large towns have increas[ed] during the last 20 years out of all proportion to [the] growth in value of the ratepayers' property.

PROPORTION OF LOCAL DEBT ATTRIBUTED TO REMUNERATIVE EXPENDITURE



TENTH ORDINARY MEETING.

/ednesday, Feb. 15, 1899; Captain BADEN VELL, Hon. Secretary to the Aeronautical ety of Great Britain, in the chair.

he following candidates were proposed for tion as members of the Society:—

·kins, Bernard, 123, Victoria-street, S.W., and ıngalore, S. India.
:nby, Walter, Castlebar, Sydenham-hill, S.E.
is, Valentine Townshend, Dene Hollow, Burgess-ll, Sussex.

he following candidates were balloted for duly elected members of the Society:—

:ridge, Edmund Walter, Kelly's Hotel, ımbay.
;, Lawrence F., Woodlands-road, Middles-ɔugh.
Gray, Mere Hall, Birkenhead.

he paper read was—

E BALLOON AS AN INSTRUMENT OF SCIENTIFIC RESEARCH.

By REV. JOHN M. BACON, F.R.A.S.

the first years of the century, the Russian demy organised, at St. Petersburg, what be regarded as the earliest balloon ascent genuine scientific research. One chief ob-which they had in view was to determine difference in conditions existing at various udes above plain country as compared those observed by Humboldt, Saussure, others at like elevations on mountain hts, and that this is even still an import-line of inquiry for which balloons are iently well suited, I shall hope to make ciently clear. The experiments proposed, h, to-day, read quaintly suggestive, were nclude an investigation of the power of rays, of the existence of electric matter, of the intensity of the colours of the prism. esults of consequence, however, were ob-:d.

ɔout the same period, Gay Lussac made riments on the same lines at Paris, ob-ng for the most part only negative results. ı a considerable interval elapsed before ntific ballooning was again seriously re-:d, when the British Association instituted ries of experiments mainly by the use of ve balloons, but without any noteworthy ess. A few years later, MM. Bixio and al made some interesting observations ıg lofty ascents chiefly on temperature tions, leading up to more important work e same direction carried on in 1852 under the auspices of the British Association, when Mr. J. Welsh obtained results of considerable value, which were published in the "Philosophical Transactions" in the following year. Some of the more remarkable of these I shall presently summarise, and endeavour to show that they suggest one important point which has perhaps scarcely received due attention.

It was practically at this stage that Mr. Glaisher took in hand those classical and exhaustive labours, which have found place in the front rank of scientific investigation of that date. The primary objects of his researches briefly put, were—To determine the temperature of the air and its hygrometric states at different elevations, and to investigate the distribution of water vapour below the clouds, in them, and above them. I proceed to present in outline certain of his more remarkable results for the purpose of bringing them into correlation with those of other aerial explorers.

Basing his deductions on 28 ascents, Mr. Glaisher was the first to prove clearly that the decrease of temperature with elevation is far from constant, as former theorists had asserted, and, moreover, that during midnight hours there is generally an increase of several degrees. In collecting results together he is careful to distinguish between clear and cloudy days, but it will suffice for my present purpose to show graphically the general law of decrease of temperature with height which he gives for clear day skies. In his own words, "the change from the ground to 1,000 feet was 6·2°, at 10,000 feet it was 2·0°, at 20,000 feet high the decline of temperature was 1·2°, at 30,000 feet high the whole decline of temperature was found to be 62°." Having thus a formula, it becomes instructive to read it in the light afforded by individual and exceptional cases; but I would first compare it with the results, already alluded to, obtained by Mr. Welsh.

This observer, in my opinion, deserves more attention than seems to have been accorded to him. Hailing from Kew Observatory, he had the advantage not only of special training, but of the best instrumental equipment that could be furnished, and his observations give proof of having been successfully carried out with the most careful attention to all details. He made four afternoon ascents during summer and autumn, under clear as well as cloudy skies, and in all four his temperature readings show one very noteworthy characteristic which I shall first describe in his own words. "The temperature of the air," he says, "decreases uniformly with height above the earth's surface

until at a certain elevation, varying on different days, the decrease is arrested, and, for a space of from 2,000 to 3,000 feet, the temperature remains nearly constant or even increases, the regular diminution being afterwards resumed, and generally maintained at a rate slightly less rapid than in the lower part of the atmosphere, and commencing from a higher temperature than would have existed but for the interruption noticed."

Let us look at this on a diagram drawn alongside Mr. Glaisher's general curve (Fig. 1). I

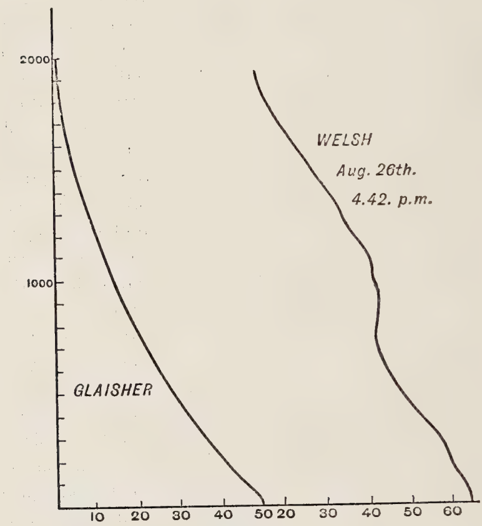


FIG. 1.

have taken a clear day in August, but the curve drawn would almost serve to illustrate each and all of Mr. Welsh's experiences. The remarkable halt he speaks of occurs in the clear air, commencing at 7,200 feet. Nine days previously, when the sun was constantly obscured, the bend in the curve commenced at 4,000 feet. On October 21, when he ascended in cloud and showers, the same bend occurs, but at 2,500 feet. Once more, on November 10, when he surmounted all cloud at 4,900 feet, the curve remains fairly regular until a height of 5,100 feet was reached, when, now well in the clear, the same remarkable check and recovery is recorded. This, I think, calls for further consideration, but returning for the present to Mr. Glaisher's account, we find him calling attention to a most instructive case which again can be illustrated by a simple figure.

It is now early spring, with wind from the S.E., the ascent commencing some two hours before sundown. The diagram explains itself, but the most important comment was supplied by Mr. Glaisher himself, who says:—" Our course was most remarkable. After pas ng over the Thames into Essex, we must hav e- crossed the river, and moved in an ent ly opposite direction until we approached he earth again, when our direction was the s ne as at first." (Fig. 2.) And now, at this par u-

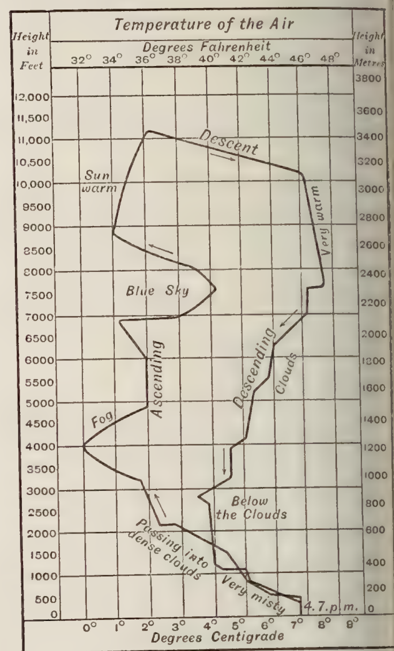


FIG. 2.

lar stage, let us compare these early re lt obtained by the balloon with typical diag m prepared from recent records systemati ll taken by high-flying kites.

Here, under a clear sky, the decrease of m perature is practically regular up to a m more, but on an occasion where cloud wa the decline has been abruptly arrested. (Fi 3

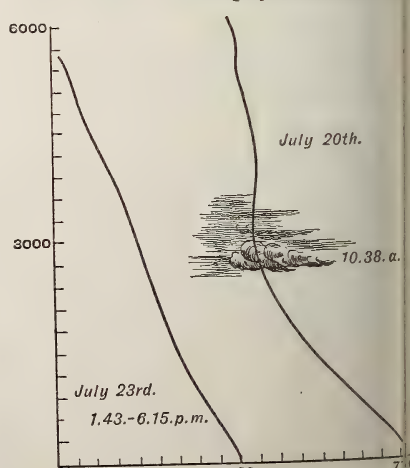


FIG. 3.

se curves accord well withthose just con-ed, and point to an agreement in the two ems of observing, each method, however, rming its special function. The types of uments used with kites should be noticed, they may be considered scarcely of such aracter as could respond very readily to d changes of temperature. Indeed, it has customary to assume that five minutes required to overcome the sluggishness of nstruments used, while, on the other hand, bserver in a free balloon can apply con-t and needed corrections, as, for instance, ne use of a simple "sling" thermometer. , when the balloon is balanced, by a mer-al barometer; and he can read from nent to moment the fluctuations in a deli-air or other thermometer as he penetrates e shallow layer. Further, the kite-flyer rly cannot, equally with the aeronaut, e sure of what is to be seen above the st cloud floor.

owever, we can already duly interpret, in light of thirty years ago, as well as of ay, a typical picture of our skies. Take a in rainy July, as given by Mr. Glaisher, h, briefly described, reads thus :—Leaving mperature of 61° on the ground, mist and rain are quickly reached, and the first ds left behind at 1,200 feet, where the perature was 59°; further cloud is sur-nted at 2,800 feet, the thermometer reading then 55°, and again 53°; then with a rt descent dry fog is reached, growing er lower down, at a temperature of 57°; nding again to 3,300 feet, the thermometer stered 53°, and finally getting down ugh squalls of wind and rain, the tempera-of earth was found unchanged. Clearly is not been established that visible cloud, that alone, affects temperature in upper ons according to any fixed law. Humidity eover has proved a very variable quantity, most obvious law involved perhaps being so commonly made patent to the eye, by liar cumulus clouds forming in daytime at ight, say of from 3,000 to 6,000 feet, and ppearing again at night.

n all-important matter, however, which had o this point been generally agreed upon by al observers, is that various currents are commonly to be found flowing within nite but shifting beds, at all and varying hts until the dominant drift is reached. prevalent trend of these greater streams indeed seriously considered as long ago he days of Green in England and Wise in America, both of these experienced aeronauts having been prepared to essay a voyage across the Atlantic by a main upper current thought to prevail in the direction of the earth's rotation.

We can now with proper appreciation pass on to consider the work embraced in the scheme rapidly developing under the auspices of the international organisation now in active progress in other countries. Supplementing the work done by simultaneous ascents of captive and free balloons, we find that far beyond the limits of human endurance the un-manned or sounding balloons, despatched from large centres lying in the heart of extended country, have ascended and brought down self-registered readings showing altitudes and temperatures never dreamed of. The experi-ments with this class of balloon, which have been conducted at Berlin under the direction of Assmann, Berson, and others, have been as successful as they have been ambitious, and with a free balloon of 8,800 cubic feet, and possessing a net lifting force of nearly 300 lbs., an altitude has been reached of upwards of 60,000 feet, as indicated by a barometric pressure of about 2 inches of mercury, while a temperature of $-88°$ Fahr. was recorded. A temperature lower yet by 6° has also been recorded by a very similar balloon despatched from Paris.

Let us look first at some of the equipment of these balloons. The German instruments have been rendered extremely perfect by the use of photographic registration, and by mechanical ventilation of the aspiration apparatus. It will be supposed that a certain unavoidable lag attaches to any such instrument, tempera-ture measurements reading too high in ascents and too low in descents, and it must also be observed that while the mean temperature of the whole mass of air is unknown, the altitudes, which are calculated on the well-known formula of Laplace, cannot be regarded as exact. Moreover, in spite of every possible pre-caution, it is open to question whether at extreme heights the registration can be relied on, and whether on that account the readings be not somewhat in error.

Balloons of the above description designed for high flights, being without controlling hand, are subject to certain disadvantages, among which must be mentioned the rapidity of vertical motion and the liability of the top of the balloon to become hollowed inwards by the pressure of the air as shown in the lantern slide. To obviate this an ingenious plan was

devised by Capt. Kowanki, for automatically emptying ballast and dropping the bag. Other considerations affect this class of miniature aerial craft. M. de Fonvielle has recently pointed out that the ascending power of the free balloon is found to depend greatly on the character of the envelope by which the enclosed gas may be caused to maintain a considerably higher temperature than the surrounding air, and thus it is found that the altitude attained may vary as much as 6,000 feet between winter and summer, and 8,000 feet between day and night.

The result of these modern researches may be to modify somewhat that sectional drawing of the atmosphere which we have hitherto regarded. I submit a diagram for which I am indebted to M. de Fonvielle of the temperature readings given by a balloon sounding the depths of the aerial ocean up to some 42,000 feet. (Fig. 4) It goes without saying that within

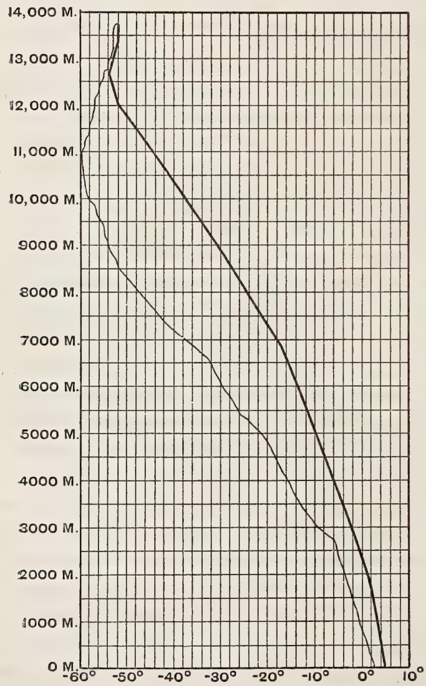


FIG. 4.

the circumscribed area of our own country, it is hardly possible to compete on equal terms in the celestial competition now being organised on the Continent, but outside meteorology there is still a field as wide as the heavens open to the balloonist for scientific inquiry.

Many years ago, we find Professor Tyndall expressing a desire to make use of a ca balloon to determine whether sound travelling to windward may not be tilted the heads of observers; and it is with ge disappointment that we read on and find on communicating with Mr. Coxwell he l that the experiment was deemed too dang to be carried out.

Having the solution of this question a chief end in view, I made arrangements series of right-away balloon ascents to place during the past summer and aut and seven in all were carried out, under ditions differing as widely as a long-conti dry season would admit of, and includin night ascent at the end of September. observations were secured that at leas directly, throw light on the above question first other facts came more readily to h Professor Tyndall, in a series of labor experiments of great refinement, showed in a tunnel or cupboard, which rem optically clear, the passage of sound was p fully influenced by differences of tempera whilst the densest fumes within these cha offered no appreciable obstacle to sound w so long as a uniform temperature was sec I proceed to submit and illustrate as the come of my own aerial research, if not a aspect of this matter, at least further cons ations of the travel of sound in our own a sphere. Broadly speaking, there have days during the past summer, equally and brilliant (as judged of by the eye, photographs taken on the ground), sounds travelling upwards have differed in penetration. This has been tested in va ways. The heights have been carefull corded when certain sounds have ceased audible, and these have very generally ex in their own due order. We find M. marion stating that the whistle of a locom rises to near 10,000 feet, the noise of a way train to 8,200 feet, the bark of a d 5,900 feet, the crow of a cock and the s of a bell to 5,000 feet, and so on, but records must be taken as mere averages, may, on occasions, have to be added diminished by as much as one-half, eve such days as (so far as can be determined earth, optically or by meteorological read have been practically identical. Similarl test of echoes from earth, verified by con repetition, have told the same tale. An test tried with the same result has bee adjustable resonator applied to the ea tuned to catch most readily the conti

ırmur from earth, sometimes to be detected this way, over a vastly extended vertical ıge.

The two series of pictures I proceed to show present two days when acoustic conditions re normal, the photographs at all heights equally and very unusually brilliant, but noteworthy fact is that on one occasion the up to 3,000 feet was unusually dry, and on other was nearly as the point of saturation. e next two series of pictures were again en in brilliant sunshine, as shown, and each re characterised equally by a blinding glare seen from above, while acoustic conditions re then entirely at variance. As one proof this, it may be stated that ground echoes oughout one voyage could not be heard ywhere at 1,000 feet, while on the other they re heard up to 2,500 feet. I would draw cial attention to the glare to which I have ıded. It is presumably due to reflection off tter in suspension. Certain particles in the er air present their sunlit surfaces to the server or camera aloft, causing a dazzling ection of light which admits of no mitiga-1, but which to the observer below has no stence. That these particles are other than se of water vapour would seem probable n the photographs I have shown. Are they t?

have made a great number of experiments determine the presence of dust in the air ing my balloon ascents by the use of an kens' dust-counter, and also by passing a own volume of air into samples of liquid, ch have been subsequently compared. I e been driven to the conclusion that dust sts at different heights, and, as it would m, not only in mere strata, but in discrete sses possibly comparable with visible clouds. ould have a similar remark to make with ard to the presence of carbonic acid. There ear to be more traces in certain tracts, and, ending to bear out this view, I would add I have made several series of uniform osures with sensitive films with the object esting the actinic qualities of light from the at different heights, and, so far as my eriments have gone, it would appear as if ude were not the only factor in the case. the clearest sky, and in the same quarter t, it would seem as if clouds of some ıre ıntervene perfectly transparent to the erver below, but offering resistance to ain waves of light and sound. Tracts of elatively warmer are very commonly pre- above. During a night ascent, having armed myself with a delicate air-thermometer, to which I gave the closest attention, I found over different localities, and at many different heights, sheets or pools of air, often shallow, 12° or 15° warmer than the temperature of earth; and, from Mr. Welsh's records already referred to, it is conceivable that something akin to an aerial gulf stream may for a whole season flow but a few thousand feet aloft.

Were an eye so constituted as to be able to see, say, cumulus masses of warmer air, strata mottled with traces of other gases, and beds of invisible matter in suspension, one might suppose that what we deem the clearest sky would then appear flecked with forms as many and various as the clouds that adorn our summer heavens.

With regard to motion in the atmosphere, it may be stated that if the loftier and broader streams of air are found confined within definite courses, it is common in lower levels to find the wind blowing in gusts that, as it were, break up aimlessly into wandering rills. This has been particularly noticeable in kite-flying experiments, before upper currents have been reached. I submit that we have an analogy here in the way in which a drop of ink, when falling through water breaks up into numerous curling streamlets. If we can picture gusts traversing by some such mode the lower strata of air, it becomes conceivable that these may be the vehicles that convey for a fleeting interval those fugitive sounds that appear for a moment to leap across great distances. These are well-known phenomena in balloon voyages, which I have studied with the conviction that, when borne upward, they are carried by ascending shafts of air leaning or wandering with the wind. A chance sound that has reached the silence above by a "long shot," has been noticed to come not so often overhead as to windward of its source. Other evidences, too, are not wanting of the erratic or sportive course of lesser currents. At upwards of 3,000 feet we have seen thistle down pass us from below, straying aloft on some unseen "up-draught." Again, we watch the cloudlet fray out in writhing wisps and twisting streamers betraying the wanton fluctuations of the stream that bears it. Professor Tyndall's observations in Hyde-park on the fitful hearing of the Westminster clock, though not made under very advantageous conditions, would support the view that the fickleness of distant sound may be in great measure due to the play of various currents. The ear was confessedly assailed by a tumult of other noise,

but clearly also the air traversed was influenced by a multitude of intervening thoroughfares, blocks of buildings, and stacks of chimneys, which must have been the certain cause of conflicting currents.

Following up the experience gained in ballooning travel, I have lately made investigations of these fugitive sounds during continuous observations carried out through day and night hours on the Maplin lighthouse, standing far out at sea, and built on framework, against which there is no appreciable lap of water. Here sometimes the higher, and again sometimes the lower, galleries catch sounds more readily, and on one noteworthy occasion the first sounds heralding the approach of a distant steamer rose momentarily over an interval estimated at five miles. In this instance there could be no argument in favour of sound waves being tilted either upwards or downwards, and I conceive that the important question of the inaudibility of sounds at certain points within due range may need very searching investigation, in which the balloon must surely be an all-important instrument of research.

I would mention, in this connection, that in one recent voyage where the balloon lazily floated at low elevation, following the line of the Bath-road westward from Newbury, the voices of countrymen, and more particularly of children, were heard easily in our wake, over distances well exceeding a mile, the wind being very light, but a party of Tyrolese singers were unheard, though performing at no greater distance in a direction across the wind.

A very special advantage of researches made by an observer in a free balloon will always lie in the complete isolation of his observatory. He has command of a region of perfect silence and tranquility, and he has the power of altering his scope and station rapidly and without disturbance. Even the direction and rate of travel of the balloon is often under control to a very considerable extent, not so much by any method of guiding, which is very limited, and attended with obvious disadvantages, but by due observance and use of the variety of those currents already spoken of, which are often within reach. As far back as the historic voyage of the "Nassau" balloon, in 1836, Green's keen observation and admirable judgment enabled him by a masterly stroke of navigation to avoid being carried, at nightfall, out over the North Sea, and to hold his desired course across the straits of the Channel.

The track of one instructive balloon journ occurring in my own experience, and exter ing over the mere width of Sussex, will se to further illustrate this point. In the Pala grounds the wind was so light that, at suggestion, the heavy grapnel was left behi so as to give us more lifting power, and w a lazy drift to the eastward we ascended easy gradient to a height of 2,400 feet, which time we were over Penge, and mainta ing the same direction. So also until we h reached 3,300 feet, and dropped again 2,400 feet, at which point we were over Bro ley and there entered a considerable curr from the north-west. Steering then a fai direct course with sundry fluctuations of hei and direction, an altitude of 8,500 feet w reached near Hawkhurst, when, our cou being rapid and nearly due south, we w quickly carried over Hastings old town. this moment, though the management of balloon was wholly entrusted to the unrival skill of Mr. Percival Spencer, I confess I w unable to see any way to avoid our dropping the sea, save by trying conclusions among forest of chimney-pots that already lay bel us. But the discrimination of our aeron was prompt and unerring, and with a disp of perfect judgment, a descent was made where the lower westerly current was o again encountered, now blowing stiffly alo shore, and we were thus brought-to near verge of the cliffs, in the outskirts of Fairli Glen.

But there are possibilities in the balloon much other physical investigation, and this virtue of the fact already insisted on, that an aerostatic observatory, we may remove selves from all disturbing influence of ea Mountain observatories may show an elevat of 4,000 feet and upwards, and even clai certain freedom from radiation off the vall by reason of lower circumjacent fogs, but very nature of a mountain is such that gro air is attracted and hangs about its hei and, as a consequence of the neighbourhoo rock surfaces more or less heated, current local origin, even under most favourable c ditions, must be constantly finding upwar downward passage on slopes of unequal varying temperatures.

The force of the wind is another difficult be reckoned with. It was said at one tim Mount Hamilton that the wind often ble the rate of 60 miles an hour, and that a gre velocity was never recorded only becaus that point the anemometers carried away.

the additional instrumental aid of prodesigned spectroscopic and telescopic s, it is reasonable to hope that at high ons we may penetrate with greater than heretofore into the ultra-violet of ectrum, and even under conditions of hed air-glare to photograph the sun's without eclipse. It is easy to conceive luable experiments can be made when is "British" of the atmosphere is left dealing with questions of refraction and problems; and, I think, we may go and even venture to hope to put to a test some of the markings on sister and other celestial wonders that have lsewhere claimed as visible with very instruments, or else, by yet happier , to banish them for good beyond the f all controversy.

DISCUSSION.

Chairman said they had had the most ng details of Mr. Bacon's numerous ascents, y as many of his experiments were of a quite unlike any previously made. The al experiments were of special interest, and no doubt prove to be of considerahle ime. He could quite appreciate what had been out the variability of gusts of wind, from his perience with kites, though he was inclined to ere had been some exaggeration with regard to urrents in different directions in the upper air. ed to him that if there were any great variety its, they would be shown by the clouds, and occasionally they did see clouds moving in directions, yet on ordinary occasions they all to be going more or less the same way. watched the stream of highest cirrus in the f the trade winds, and it was wonderful how he current seemed to flow in the opposite direc- the trades, though the motion appeared very nd would probably escape the notice of the observer, unless it were watched against lestial body, such as the moon. He knew the there was in ballooning from not being able d on one current of air. On one occasion he ascent from Aldershot, with the intention of Ascot; the day was cloudy, but they got he clouds, and, after a time, thinking they about over Ascot, descended, and found es on the other side of Guildford, having gone st exactly the opposite direction to what they l. This led to the question of balloon steer- l he could not help referring to the latest with regard to the bold adventurers who some two years ago to explore the Arctic These reports seemed ro have more ce of truth than some previous rumours, and though it would be very sad if the death of those brave explorers were confirmed, it would be some satisfaction to have a record of their journey. Several attempts had recently been made to test the principles adopted by Andree—of steering by a sail and a guide-rope—but, unfortunately, they had been rather meagre, and he hoped to take part soon in some more thorough tests of longer duration. But, after all, this method was somewhat rough and primitive; and what the public wanted to know was when there would be a really navigable balloon. There was, in his opinion, only one simple reason why that had not been attained, and that was that they could not get the needful money. Hitherto, all attempts had been on a very small scale, and the balloon of to-day must be compared to the coracle of the ancients. It was a small vessel, capable of lifting two or three men, and simply drifted with the current. Occasionally attempts had been made to propel a balloon against the wind, and on several occasions one had been propelled at the rate of some 14 miles an hour, but they were only small experiments in what we may call aerial canoes. They had recently read about the greatest attainment in modern shipbuilding, the *Oceanic*. He had made calculations, from which it appeared that if, instead of being an ocean liner, she had been an aerial vessel with a length of 700 ft. and a diameter of 70 ft., she would contain 2,500,000 cubic feet of hydrogen, and would lift a weight of 180,000 lbs. With due allowance for the weight of such a structure with engines of some 2,000 horse power, there would still be available lifting power to carry 200 passengers, or soldiers with their arms, and he could not see any insuperable difficulty in constructing a balloon of that size, with engines which would give a speed of 30 miles an hour. Even if such a vessel were dependent upon fine weather, would it not be most useful? He looked on these things from a military point of view, and he thought such an instrument would be of incalculable value not only in a European war, but for such purposes as fighting amongst the pathless mountains on the Indian frontier, or the swamps of Africa. They had heard a good deal lately about universal peace, but he thought this would be a solution of the difficulty, for if one nation possessed such powerful machines, she could dominate all others. England, by possessing a strong navy, was able to dictate to other nations, and she would be in a still stronger position if she possessed powerful machines capable of traversing the air. Perhaps this was rather diverging from the subject of the paper, but with regard to scientific research also, most extraordinary results would be attained by means of navigable balloons. If they had frequent reports of the state of the atmosphere at all heights, round the country and out at sea, practical meteorology would be very much assisted. All difficulties, too, of geographical research would disappear.

Admiral Sir Erasmus Ommanney, K.C.B.,

asked whether the magnetic compass retained its directive force at high elevations.

Mr. PERCIVAL SPENCER said he had listened to the paper with the greatest pleasure, for though he had had the honour of accompanying Mr. Bacon on most of his ascents this was the first time he had seen the photographs. The meetings of the Aeronautical Society generally dealt with abstruse subjects more visionary than real, but here they had seen the actual results. The last time he was in that room it was to listen to an account of a flying machine by Mr. Davidson; it seemed to be a cross between a navvy's pick-axe and a blacksmith's anvil, and though the author demonstrated theoretically how well it would work, he was not aware that he he had ever got an inch off the ground with it. In former days the Balloon Society dealt occasionally with this subject, but it had now ceased to exist, and given place to the Aeronautical Society, and he should like to see its discussions take a more practical turn. Mr. Bacon had shown how a balloon could be used as a floating observatory, and it was evident that a great deal could be done with balloons even as they existed at present. It was all very nice to talk about steering balloons, but there was one unfortunate point to be borne in mind. When in an ordinary balloon, going with the wind, you were in an absolute calm; but if an immense aerial machine such as the Chairman had described, were constructed, propelled with enormous force, all that would be changed, and the pleasures of ballooning would give way to the ordinary discomfort of a sea voyage. He well remembered how tranquilly he floated across to Havre recently in a balloon, and how in coming back by steamer, he was interrupted many times in writing his article for the *Times*, by occurrences which were anything but pleasant.

Mr. ERIC S. BRUCE thought one of the first things to be aimed at in balloon manipulation was an improvement in the power of vertical motion, so as to be able to rise without a sacrifice of ballast, and to descend without a sacrifice of gas. It had been said that ballast was the life-blood of a balloon, and it was quickly exhausted. It was, of course, a difficult problem, but he could not help thinking that Professor Dewar's achievements in liquefying hydrogen might be turned to advantage. At any rate, this was the most important thing; the direction of horizontal motion was quite secondary. Mr. Bacon was to be congratulated on his efforts to explore the higher regions of the atmosphere, for meteorological science was being kept back from the want of men of sufficient heroism to trust themselves to a bag of gas; and it was a great pity that more systematic experiments could not be carried on in this direction. Mountain stations were always affected by terrestrial disturbances, and the value of isolated observations had been shown even in the case of the Eiffel Tower. I believed that the varying currents depended very on the electrical condition of the atmosphere, fo were very frequent during thunderstorms. H made a number of experiments in Switz with pilot balloons when thunderstorms w progress, and found that numerous currents flowing in different directions, though he had no i ments on the balloons by which the currents co measured. The thanks of all interested in aeror were due to the Chairman for having practica suscitated the Aeronautical Society. He had inc not only the number but the quality of the men having persuaded some eminent men of scien join, and to take an interest in the subject, must tend to stimulate invention and discovery.

Mr. G. FENTUM PHILLIPS thought Gover ought to find the money necessary for constr aerial machines. The nation which first posse navigable balloon would certainly be in a posit dictate to other powers; and such an achiev would be far more practical than any amount about universal peace. When they saw govern like that of the United States or Great Britain ing a million and a-half on a battle-ship, which be utterly useless in the presence of an aerial he thought the Government might reasonab asked to vote a certain sum of money to a c formed of scientific men and engineers, to practically with this question. You could not a private individual, even if he were a million devote half his life and the whole of his fortu project from which he would derive no benefit.

Mr. LEON GASTER said an ordinary sized b was quite sufficient for scientific research, and not think an immense structure, such as the Ch had alluded to, rendered buoyant by gas, wo a practical machine. For the purposes he view, a flying machine would have a much prospect of success.

The Rev. J. M. BACON, in reply, said regard to the magnet, Mr. Glaisher had rea great an altitude as anyone, and it was one favourite experiments to test the oscillations magnet under all circumstances. He had recorded any failure of the directive power. H instrumental equipment was so inadequate t could not give any personal opinion on the q raised.

The CHAIRMAN then proposed a cordial v thanks to Mr. Bacon, which was carried unani and the meeting adjourned.

Miscellaneous.

FOREST WEALTH OF BRITISH COLUMBIA.

he consideration of the economic products of Columbia, the timber wealth naturally takes a ent part, as apart from minerals it represents the nportant and readily available results. British bia may be said to possess the greatest comrea of merchantable timber on the North can Continent, and if it had not been for at forest fires that have raged in the interior s gone by, during which a very large portion surface has been denuded of its forests, the le supply would have been much greater than As far north as Alaska, according to a recent by the secretary of the British Columbia of Statistics, the coast is heavily timbered, est line following the indents and river valleys nging the mountain sides. Logging operations have extended to Knight's Inlet, a point of ist of the mainland opposite the north end of uver Island. Here the Douglas fir, the most ant and widely dispersed of the valuable trees, ears altogether, and the cypres or yellow akes its place. North of this, cedar, hemlock, ruce are the principal timber trees. It will be rest to know that Douglas fir was named after Douglas, a noted botanist who explored New nia in the early part of the century. It is a videly distributed tree, being found from the o the summit of the Rocky Mountains, and east as Calgary, and as far north as Fort od. On the coast it attains immense proporsometimes towering 300 feet in the air, and a base circumference of from 30 to 50 feet. s the staple timber of commerce often classed trade as Oregon pine. It has about the same c gravity as oak, with great strength and has range of usefulness, being especially adapted ilding purposes. It is scientifically described nding midway between the spruce and the , and in the opinion of the Dominion list is a valuable pulp-making tree. Probably o next most important representatives of the wealth are the red cedar and the yellow cedar. rmer is found all over the province, but reaches atest development on the coast where it outall others. In addition to its commercial value ingles and finishing purposes, it is the friend settler, inasmuch as out of its straight-grained e can build his house, make his furniture, and his farm, and that with the use of the most ive tools only. It is especially valuable, howfor interior finishing, being rich in colouring, aking a beautiful polish. For this purpose it ing an extended market in the east of Canada. tant as the red cedar is, the yellow cedar, though much more limited in area and quantity, is still more important and useful. It is very strong, comparing with the Douglas fir in this respect, is wonderfully durable, finishes to perfection, and grows to great dimensions. The cypress, which is found in great quantities in the interior of Vancouver Island, and on Mount Benson, near Nanaimo, comes within 1,200 feet of the sea. Towards the end of the island, on Queen Charlotte Islands, and on the north coast of the mainland, it is found lower down and is very plentiful. It is out of the cedar that the Hydah Indians build their celebrated war canoes, some of which have an eight foot beam, are 60 feet long, and can stem the heaviest seas of the coast waters. Next comes the white spruce. Its habitat is principally low, swampy, and delta lands, usually interspersing the forest of fir and other trees, but in no place is it found on very large or compact bodies. From its comparative scarcity and the many uses to which it may be put, it is commercially more valuable than the Douglas fir. It attains a circumference almost equal to the latter, but does not grow so tall or so clear of branches. It is utilised largely in making doors, salmon boxes, barrels, fruit boxes, and many other similar purposes, being as it is, the best adapted for these uses of all the native timbers. It is *par excellence*, the wood for pulp manufacture, which is expected to become one of the most important industries of the province. Hemlock is a common timber, and up the coast is found in considerable quantities. It is a useful tree and answers about the same purpose as the Douglas fir, and for that reason it will not be in general demand until the latter has become to some extent exhausted. White pine for cabinet purposes and general utility is very valuable, but is limited in quantity. Balsam is widely distributed, being found principally in river valleys, but is commercially of little value except for pulp. With the exception of the yew, and tamarack, of which there are several varieties, the foregoing are the representatives of the family of coniferous trees. Of deciduous trees, the large leaf maple, vine maple, alder, crab apple, oak, two varieties of poplar or cottonwood, and aspen poplar, arbutus, birch, willow, and juniper, are the principal. The maple, alder, and arbutus make first-class cabinet woods, though they are not abundant enough to be extensively used for this purpose. They also make popular finishing woods. Poplar, or as it is most commonly called, cottonwood, will, it is expected in the future, be greatly used in paper making. The aspen poplar is common in Vancouver Island and the northern interior of the province. It is also a good paper maker. The oak is mainly confined to the southern end of Vancouver Island. It is a stunted, gnarled species, of little use, but very picturesque. Crab apple is plentiful in swampy places, around ponds, beaver meadows, and along river banks. The hard woods are usually found in bottom lands and indicate fruitfulness of the soil. There is no part of British Columbia where the timber supply is not

sufficient for local demands. There are over eighty sawmills in the province, large and small, with a daily capacity of about 2,000,000 feet, mainly on the coast, but the limit has never been reached, the annual cut running between 50 and 100 million feet. Various estimates have been made of the amount of timber in sight. These range between 40 and 100 billion feet. The average of timber under lease is about 1,175 square miles, and the total area of forest and woodland s put down by the Dominion statistician as 285,554 square miles, but this must not be taken as all of commercial value, as much of this is covered with small trees suitable only for a local supply of fuel and lumber. The future of the lumber industry in British Columbia is very promising, and when foreign demand fully revives, and the Nicaraguan Canal has been completed, it cannot fail to receive an immense impetus.

Correspondence.

THE JABLOCHKOFF KAOLIN-CANDLE LAMP OF 1877-8, *COMPARED WITH PROF. NERNST'S NEW ELECTRIC LAMP OF* 1898-9.

Mr. G. Hurlstone Hardy writes as follows:—As the instructive discussion lasted so long after Mr. Swinburne's most excellent paper describing Nernst's new invention, I thought it as well, the hour being late, to refrain from intruding my observations upon the audience. However, after reading this week's *Journal* I do think that something should be said for a more adequate appreciation of the career of Mons. Paul Jablochkoff. I had the opportunity of taking the greatest possible interest in Jablochkoff's inventions, by reason of my then superintending (on behalf of the late B. Woodcroft, F.R.S.) the Patent-office abridgements relating to electricity and magnetism, a revision of which unwieldly work I was then engaged upon preparing in the six distinct groups which have been adopted with but little change (and no improvement) by the new Patent-office technical staff. The late W. H. Walenn, and the late Dugald Campbell, then engaged by the Commissioners of Patents, were both concerned, the latter especially, as professional experts in the British exploitation of Jablochkoff's inventions which were said to have suffered from not falling into good hands, financially. However, I, as the very intimate colleague of Mr. Walenn and Mr. Campbell, am here only concerned in upholding the high merit of Jablochkoff's inventions. One speaker, at least, predicted shocking attempts to rob Professor Nernst of his glory and due reward. The real merits of the eminent professor hardly require to be enhanced by such observations, which seemed to me to savour of the slightly too obtrusive championship of the company promotor type. Professor Nernst's fame will survive paltry attacks as well as overwi[...] flattery; it must in the end be gauged by re[...] and critical study, without shutting one's eyes [...] source of knowledge new or old.

Jablochkoff's "kaolin-candle" lamp can o[...] read about in his specification of Letters Pat[...] 1877, but the whole series of the specifications [...] patented inventions should be perused to asc[...] the exact degree to which Jablochkoff advance[...] common knowledge in the direction of Pr[...] Nernst's brilliant invention. My own recoll[...] and persistent inquiries of Messrs. Campbel[...] Walenn, respecting the kaolin-candle, enable [...] be very confident that Jablochkoff was a conscie[...] worker, and no mere presumptious patent[...] anticipated but untried possibilities.

At the great electrical exhibition, held i[...] Albert-hall, Jablochkoff's kaolin-candle lamp [...] shown and lighted up, but the inventor an[...] exploiters chose rather to expend their energ[...] electric lighting, with the aid of their "c[...] candle," which consisted of two parallel carbo[...] cemented together by a white material (clay or [...] or a compound of whiting, &c. I was much [...] by Jablochkoff's persistence in maintaining th[...] "carbon-candles" owed much of their light-[...] power to the glow of the incandescent cement[...] this day I have inclined to believe him against a[...] allegations of electricians who assured me t[...] contrary, giving as their inconclusive proof [...] Jablochkoff's arc lamp consumed more current [...] the more ordinary forms of arc lamp. Apart [...] financial troubles, the disuse of Jablochkoff's c[...] candles was attributable to the imperfection of c[...] rods as then made; this fact rendered the auto[...] re-lighting of the Jablochkoff arc lamp, when [...] dentally extinguished, not as facile as other arc l[...]

Now, as to the comparatively unknown "k[...] candle" lamp. Jablochkoff has placed on rec[...] the patent specification, No. 1996 of 1877, [...] necessary detail with admirably lucid explan[...] considering the state of electrical knowledge a[...] time. The illustrated description of the kaolin-[...] lamp, together with the public exhibit thereof, est[...] facts that cannot be impeached. I was myself [...] the Albert-hall that the kaolin-candle was ignit[...] the use of a piece of lead attached to the po[...] "slab" as an initial conducting "match." Re[...] to be content with this explanation my eager [...] inquiries were satisfied by Mr. D. Campbell, [...] informed me that the igniting match was compo[...] graphite or carbon powder and treacle dried up[...] porcelain, in fact what a housemaid would call [...] lead paste. This confusion of lead and blac[...] reminds me of the misunderstanding of a puisne [...] who (in a trial for the infringement of a pate[...] soldering lead pipes) astonished the Court by a [...] observation:—"Do you know," said the judge [...] hearing of all the bystanders, "I read a singul[...] the other day; there is only one single lead m[...] the world; it is in Cumberland, and in order t[...]

the supply it is opened only for three days in the

lochkoff certainly thought that his two kinds of greatly resembled each other in principle, gh he clearly observed that his carbon-candles consumed rapidly, whilst the kaolin-candle orated so slowly as not to require daily renewals. chkoff said that his kaolin-candle (or as a substi- slab of some other refractory body) yielded a nt light, whilst the substance was slowly con- l. From my own casual observation I should alled the light bright, but by no means dazzling, should have said that the so-called "candle" red not consumed in the slightest degree, the ch" only being consumed.

lochkoff gave one single explanation of the led electric arc or glowing air-gap. Respecting nvection of current through "non-conductors," id that where one electric spark travels, there a is prepared whereby a succession of sparks can their way; that a non-conducting refractory (placed between two terminals) will, under the nce of the electric current, become an active ictor along all points touched by the sparks; that it will become heated to incan- nce. A "tension current," he explained, l his object best, and that a "quantity" current l consume the kaoline. He worked his lamps, ably, by the alternating current, but they could stalled on a continuous current circuit by the osition of interrupters and condensers.

far as the progress of the world at large is ed, the only gauge of merit is success. Hence e-discovery of a forgotten invention, or the re- luction and improvement of a neglected inven- may be as great a benefit as any other more al invention. As ranking in a purely theoretical of merit, an extra meed of praise seems due to an who achieves a great discovery at the early when scientific knowledge did not so clearly lead ay, and who may have utterly failed to achieve ss, perhaps, because countenance and support acking to his best efforts.

Obituary.

ORGE A. SPOTTISWOODE.—By the death of Mr. ge A. Spottiswoode the Society of Arts loses a ber of 46 years' standing, Mr. Spottiswoode g joined the Society in 1853. He was born in and at an early age became associated with the printing establishment whose fortunes he had ssfully directed for many years before his death. ook great interest in Church matters, having been iated with many Church institutions, and being time of his death Vice-Chairman of the House ymen of Convocation. Mr. Spottiswoode served Member of Council for a short time in the year

General Notes.

IRON FELT.—This is the name given to a new insulating substance made at the Adlershof Works, near Berlin, and for which numerous applications have been found. The felt consists essentially of long and strong woollen fibres, impregnated with a by-product of petroleum, and then coated (with a certain amount of penetration) by gelatine rendered insoluble, and also (alternatively or in addition) with india-rubber, afterwards vulcanised. After being subjected to considerable pressure, the iron felt assumes the form of plates, measuring 20 sq. dm. (2 sq. ft. 22 sq. in.) and upwards, with a thickness varying from 1 to 5 centimetres (13-32 in. to 2 in.). These plates are very elastic, being practically imperishable, while they will stand a pressure of 1,458 kg. per sq. cm. (20,736 lbs. per sq. in.); and their surface is so hard as not to be cut by the sharp edges of bolt heads or of iron girders. Placed as a cushion between rails and their chairs, or sleepers, underneath plummer-blocks or between engines and their foundations, this substance is also stated, by *La Nature*, to prevent vibration.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 22.—"The Gold Mines of West Africa." By JAMES IRVINE.

In consequence of the indisposition of Mr. Philip Dawson, his paper on "Electric Traction," announced for the 22nd, has had to be suddenly postponed. Due notice will be given of the date on which it will be read.

MARCH 1.—"Leadless Glazes." By WILTON P. RIX.

MARCH 8.—"Cornish Mines and Miners." By J. H. COLLINS, F.G.S.

MARCH 15.—"Liquid Fuel." By Sir MARCUS SAMUEL. Sir EDWYN S. DAWES, K.C.M.G., will preside.

MARCH 22.—"London's Water Supply." By WALTER HUNTER, M.Inst.C.E.

Dates to be hereafter announced:—

"Preservation of Timber." By S. B. BOULTON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 9.—"Leprosy in India." By H. A. ACWORTH, C.I.E., late Government Municipal Commissioner for the City of Bombay.

This meeting will be held at the Imperial Institute.

Foreign and Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

FEBRUARY 28.—"Persian Trade Routes." By A. HOTZ. Major-General Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., will preside.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

FEBRUARY 21.—"Vitreous Enamels." By CYRIL DAVENPORT. Sir OWEN ROBERTS, M.A., D.C.L., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

LECTURE I.—FEBRUARY 20.

Introduction—The modern bicycle—The frame—Strength and stiffness—Pedal pressure—Chain-struts—Round, D, and rectangular tubes—Frame of lady's bicycle—Tandem frames—Front-fork—Spring-frames.

LECTURE II.—FEBRUARY 27.

Ball-bearings—Hubs—Pedals—Crank-brackets—Steering-head — Adjustment — Wheels — Direct-spokes—Tangent-spokes—Rims—Materials used in cycle construction—Steel—Malleable-iron castings—Wood.

LECTURE III.—MARCH 6.

Driving gears—Length of crank—Block chain—Roller chain—Chain-wheels—Bevel gear—Lloyds' cross-roller gear—Compound gears—Two-speed gears—Free-pedals—Tricycle-axle.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Archibald Sharp, "Cycle Construction and Design."
Imperial Institute, South Kensington, 8½ p.m. Sir Horace Tozer, "Thirty-eight Years in Queensland."
Surveyors, Savoy-street, W.C., 8 p.m. Mr. J. L Crouch, "The Management and Valuation of Brickfields."
Cleveland Institute of Engineers, Middlesbrough, 7½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m. Messrs. J. M. Brydon and F. J. Burgoyne, "Municipal and Public Libraries."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Professor Beale, "Life."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Sidney Lee, "Shakespeare in Folio."

TUESDAY, FEB. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Cyril Davenport, "Vitreous Enamels."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lancaster, "The Morphology of the Mollusca." (Lecture VI.)
Civil Engineers, 25, Great George-street, S. p.m. Discussion on paper by Messrs. Jer and Archibald P. Head, "The Lake Superio Ore Mines and their Influence upon the Pr tion of Iron and Steel."
Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Price Howell, "Comparative Statistics of A lasian Railways."
Pathological, 20, Hanover-square, W., 8½ p.m.
Photographic, 12, Hanover-square, W., 8 p.m. F. H. Glew, "Demonstration with Violet E Waves for actuating Photographic Apparatu for Photographing Lightning in Daylight."
Anthropological, 3, Hanover-square, W., 8½
Zoological, 3, Hanover-square, W., 8½ p.m. F. P. Moreno, "A Portion of Skin, *Neomylodon listai*, from a Cavern near Co Cave, Last Hope Inlet, Patagonia; with a d tion of the Specimen by Mr. A. Smith Wood 2. Surgeon P. W. Bassett-Smith, "The F tion of the Coral Reefs of the N.W. Co Australia." 3. Mr. G. A. Boulenger, "A C tion of Reptiles and Batrachians, made by D. La Touche in N.W. Fokien, China."

WEDNESDAY, FEB. 22...SOCIETY OF ARTS, John- Adelphi, W.C., 8 p.m. Mr. James Irvine, Gold Mines of West Africa."
Geological, Burlington-house, W., 8 p.m. 1. T. G. Bonney and Miss C. A. Raisin, "V of Serpentine and Associated Rocks in Angl 2. Miss J. Donald, "Remarks on the *Ectomaria*, Kohen, and *Hormotoma*, Salter.
Japan Society, 20, Hanover-square, W., 8 Mr. Chokuro Kadono, "Japanese Railways
British Astronomical, Sion College, Vi embankment, W.C., 5 p.m.

THURSDAY, FEB. 23...Royal, Burlington-house, W., 4
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., Rev. Canon Benham, "Winchester Cathedr
Sanitary Inst., 74A, Margaret-street, W., 8 Dr. Herbert Manley, "Sanitary Law."
Royal Institution, Albemarle-street, W., Dr. A. Macfadyen, "Toxins and Anti-T (Lecture III.)
Electrical Engineers, 25, Great George-street, 8½ p.m.

FRIDAY, FEB. 24...Royal Institution, Abemarle-stre 8 p.m. Weekly Meeting. 9 p.m. Prof. Lodge, "Coherers."
Civil Engineers, 25, Great George-street, 8 p.m. (Students' Meeting.) Mr. R. Mackay, "The Loss of Heat from Buildin
East India Association, Westminster Tow 3½ p.m. Lieut.-Col. R. C. Temple, "T velopment of Currency in the Far East."
Clinical, 20, Hanover-square, W., 8½ p.m.
Physical, Chemical Society's Rooms, Burl house, W., 5 p.m. 1. Mr. E. F. J. Love Joule-Thomson Thermal Effect." 2. Mr. Griffiths, (*a*) "A Study of an Apparatus Determination of the Rate of Diffusion of Dissolved in Liquids;" (*b*) "Note on the of Energy in Diffusive Convection."

SATURDAY, FEB. 25...Education Department, South K ton Museum, S.W., 3½ p.m. Mr. William "Pottery.."
Botanic, Inner Circle, Regent's-park, N.W.,
Royal Institution, Albemarle-street, W., Lor leigh, "The Mechanical Properties of B (Lecture III.)

[Jou]rnal of the Society of Arts.

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[F]RIDAY, FEBRUARY 24, 1899.

[All co]mmunications for the Society should be addressed to [the] Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

[On] Monday evening, 20th instant, Mr. [ARC]HIBALD SHARP, A.M.Inst.C.E., delivered [the fi]rst lecture of his course on "Cycle Con[struc]tion and Design."

[Th]e lectures will be published in the *Journal* [durin]g the summer recess.

APPLIED ART SECTION.

[Tu]esday evening, February 22, 1899; Sir [OWE]N ROBERTS, D.C.L., F.S.A., in the chair. [The p]aper read was on "Vitreous Enamels," [by CY]RIL DAVENPORT.

[Th]e paper and report of the discussion will [be pr]inted in the next number of the *Journal.*

[Th]e paper announced for March 14, on ["Cra]ftsmanship and its place in a National [Sche]me of Art Culture," by Sir WILLIAM [BLAK]E RICHMOND, K.C.B., R.A., is un[avoid]ably postponed.

COVERS FOR JOURNAL.

[For] the convenience of Members wishing to [bind] their volumes of the *Journal*, cloth [cover]s will be supplied post free for 1s. 6d. on application to the Secretary.

[Pr]oceedings of the Society.

[R]EPORT OF COMMITTEE ON ACETYLENE GENERATORS.

[Com]*mittee.*—Major-General Sir Owen Tudor [Burn]e, G.C.I.E., K.C.S.I. (Chairman); Sir [Frede]rick Bramwell, Bart., D.C.L., F.R.S.; [Profe]ssor James Dewar, M.A., LL.D., F.R.S.; Harry Jones, M.Inst.C.E.; Professor Vivian B. Lewes; Boverton Redwood; Professor Sir W. C. Roberts-Austen, K.C.B., F.R.S.; Professor J. M. Thomson, LL.D., F.R.S.; Sir Henry Trueman Wood, M.A. (Secretary).

The following is the Report of the Committee on the Exhibition of Acetylene Generators at the Imperial Institute (opened June 15th, 1898):—

To the Council of the Society of Arts.

GENTLEMEN,—We, the undersigned, having been constituted a Committee by the Council of the Society of Arts, to enquire into and report to them on the requisite conditions of safety in Acetylene Gas Generators, and also to lay down rules as to the admission of apparatus to the Exhibition of Acetylene Gas Generators held at the Imperial Institute in 1898, have the honour to submit to you the following report:—

It being common knowledge that amongst the large number of generators constructed and sold to the public, there were some which did not conform to the ordinary conditions of safety, it was felt that in undertaking an Exhibition of Generators for Acetylene to be held at the Imperial Institute, a preliminary test should be made of all the generators submitted for exhibition, and that the generators which did not satisfy the necessary conditions should be rejected.

The London County Council generously placed at the disposal of the Committee, premises in the Harrow-road, where the preliminary tests of all the generators submitted were carried out, and the various forms of apparatus as they were passed having been forwarded to the Imperial Institute, the Exhibition there was opened on June 15th, 1898.

Although beyond the scope of their instructions, your Committee felt that in the interests of the public, it was advisable to carefully test the various forms of generator working for the period of a month, as it was possible that defects which might not be apparent in the test extending over a few hours might be detected on working over a longer period.

Professor Vivian B. Lewes and Mr. Boverton Redwood were appointed as a Sub-Committee to examine into the working of the acetylene generators exhibited at the Imperial Institute, and to report to the Committee as to the results obtained and as to the generators to which

certificates should be granted. The method adopted for testing is shown in Appendix C.*

As the result of these tests, the Committee advised the granting of certificates for those forms of acetylene generators, a list of which is appended, the certificate, however, merely setting forth that the generator had complied with the requirements of the various tests to which it had been submitted, and had worked safely and satisfactorily during a month's every day use.

The Exhibition at the Imperial Institute has clearly demonstrated that many types of acetylene gas apparatus can be so constructed as with ordinary precaution to be absolutely safe, and that lighting by acetylene need be no more fraught with danger than are any of the other forms of artificial lighting in general use.

In granting certificates to the various makers of apparatus herein-before mentioned, we wish it, however, to be clearly understood that such certificate can only apply to the type of machine examined and tested by us, and must not be taken as applying to all and every class of machine which may be offered for sale by the same makers. By type of machine is meant apparatus of the designs shown in Appendix E.

We consider that the various makers of apparatus who, at so early a period in the development of acetylene lighting, submitted their machines to the rigid tests as to safety laid down by your Committee, and have obtained certificates, are entitled to the first consideration from the public.

There may be other forms of generators not exhibited at the Imperial Institute, which are perfectly reliable, but we strongly recommend that no machine should be purchased from any maker or dealer unless a certificate can be shown from some competent authority to the effect that it complies in substance with the rules laid down in Appendix B, and that it has been submitted to and has satisfactorily passed the tests indicated in that Appendix. In this respect, fire insurance companies could render great assistance to the public in refusing to insure without such certificate being forthcoming.

General conclusions as to the working of each generator during the testing period are given with the diagrams. All the machines to which certificates were granted worked satisfactorily, some better than the others. It is only fair to state that in the few instances where shortcomings are indicated the defects were in many cases remediable, and that possibly, owing to the experience gained by the exhibitors during the testing period, they may have since been remedied. Apparatus, therefore, should not be condemned because during the trials the working in any particular case was not all that could be desired.

A point of considerable interest is the volume of acetylene gas produced per lb. of carbide used in each generator. Amongst the *automatic* generators there were three which gave over the whole of the testing period an average of slightly more than 4·5 cubic feet per lb., the remainder varying from slightly under 4 to as low as 3·55. Amongst the *non-automatic* generators one gave an average of about 5 cubic feet, the others showing much less.

The carbide of calcium used both at the Harrow-road and at the Imperial Institute was supplied in bulk by the Acetylene Illuminating Co., Ltd., from Foyers, and was found to be throughout of excellent quality. It was weighed out and supplied to the exhibitors by Mr. Duffield, the assistant appointed by the Committee.

Although it does not follow that the generator which yields the largest amount of gas is necessarily the best, yet this factor is a most important one in the choice of any apparatus. The generators which combine the largest yield of gas with strength of material and simplicity in charging the carbide, and in emptying the residue are those which will recommend themselves to the public.

Where the public is most likely to be misled is by the exaggerated claims made by makers as to the number of lights which a given machine will supply, and herein may possibly be an element of danger due to excessive heating caused by too rapid generation. Even if there be no danger, the overheating will considerably lessen the quantity and lower the quality of the acetylene gas evolved from the carbide, as well as tending to cause smoking of the burners, as pointed out in Appendix F.

We recommend that every apparatus sold should be accompanied by a written guarantee that it will light a specified number of burners, consuming a given quantity of gas per hour, over a consecutive number of hours, without increasing the temperature in any part of the carbide receptacle, above 228° C., that is to say, the fusing point of tin.

In regard to precautions to be taken we endorse the suggestions of the Public Control Department of the London County Council and of the Corporation of the City of London.

As to licenses for storing carbide of ca

* The Appendixes are printed separately, and are not given in the *Journal*. See note at end of Report.

n, we consider that Local Authorities need e no hesitation in granting such licenses storage provided it be shown to their satis-ion that the material is properly packed, l that it is intended to store it in some dry l well ventilated place.

Ve consider that no carbide should be pur-sed without a guarantee that it is free from impurities in quantities sufficient to cause iger, and the name and address of the nufacturer should be given on each package. should also be guaranteed to give off an rage of 5 cubic feet per pound of carbide en used in a good generator.

As will be seen from Appendix G, the Home ice regulations allow 5 lbs. of carbide to be ot without a license in packages of 1 lb. h. We recommend that however small the antity, it should always be kept in closed s or bottles, under lock and key, and in a place. When its properties are more fully own, these precautions may not be necessary it is no more dangerous than many other ostances in daily use.

It was not within the scope of the work of the mmittee to report upon portable apparatus d lamps to be used within the house. Your mmittee, however, feel it their duty to state t safe as they consider acetylene gas to be, en generated in a properly constructed paratus outside the building to be lighted, d in accordance with the rules and sug-stions contained in this report, they are of inion that the generation of gas within the use is not unattended with danger, except skilled hands.

As to cycle lamps, carriage lamps, &c., ough requiring only small charges of carbide, consider that great care is required in their nipulation.

We consider that non-automatic generators th a holder capable of taking the gas gene-ed from the largest charge of carbide the nerator will hold, are free from objections ending all automatic generators examined us, and we are of opinion that every generator ould be fitted with an arrangement by which air can be rinsed out of the generating amber by acetylene or some inert gas before tion is allowed to commence between the ter and carbide.

We are also strongly of opinion that every nerator should be fitted with a purifying amber or chambers, in which the acetylene purified from ammonia and sulphuretted d phosphuretted hydrogen and from other purities.

The thanks of the Committee are due to Mr. F. G. Worth, of the Acetylene Illuminating Company, for the help he has given them throughout the investigation.

We have the honour to be

Your obedient servants,

OWEN TUDOR BURNE.
FREDERICK BRAMWELL.
JAMES DEWAR.
HARRY JONES.
VIVIAN B. LEWES.
BOVERTON REDWOOD.
W. C. ROBERTS-AUSTEN.
J. M. THOMSON.
HENRY TRUEMAN WOOD
(Secretary).

LIST OF FIRMS TO WHOM CERTIFICATES HAVE BEEN GRANTED.

Automatic Generators.

The Abingdon Acetylene Illuminating Co., Ltd., 97, Great Hampton-street, Birmingham.

The Acetylene Beacon Light Co., Ltd., 59-61, Colmore-row, Birmingham.

The Acetylene Gas Corporation, Ltd, 100C, Queen Victoria-street, London, E.C.

The Acetylite Syndicate, Summer Works, Summer-lane, Birmingham.

Appleby & Harris, 2, Broadway, London-fields, London, E.

Bailey & Clapham, Eagle Works, Keighley, Yorks.

British Acetylene Gas Generator Co., Ltd., Kirkcaldy, Scotland.

Ehrich & Graetz, Lausitzer Strasse, Berlin.

Exley & Co., Byram-street, Huddersfield.

Sir Charles S. Forbes, Bart., Castle Newes, Strathdon, Aberdeenshire.

International Industrial Syndicate, Ltd., 82-84, Bishopsgate-street, London, E.C.

Liver Acetylene Gas Co., Ltd., 4, York-buildings, Dale-street, Liverpool.

Manchester Acetylene Gas and Carbide Co., Ltd., St. Simon-street, Salford, Manchester.

Midland Acetylene (Parent) Syndicate, Ltd., Cradley-heath, Staffs.

Read Holliday and Sons, Ltd., Huddersfield.

Sardi's Patent Gas Generator Syndicate, Ltd., 25 New Broad-street, E.C.

Strode and Co., 48, Osnaburgh-street, Regent's-park, London, N.W.

Thorn & Hoddle, New Tothill-street, Victoria-street, London, S.W.

Thornton - Scarth Automatic Lighting Syndicate, Ltd., 37, Vittoria-street, Birmingham.

Non-Automatic Generators.

The British Pure Acetylene Gas Syndicate, Ltd., 19, Castle-street, Liverpool.

Ideal Gas Co., Ltd., 3, Tacketts-street, Blackburn, Lancs.

Pintsch's Patent Lighting Co., Ltd., 38, Leadenhall-street, London, E.C.

Sunlight Gas Co., Ltd. (Goodwin's System), 18 and 19, Wellington-quay, Dublin.

The Report is also issued in pamphlet form, with appendixes giving particulars of the tests, diagrams of the apparatus, &c. The price is one shilling; it can be obtained from the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

Any member desiring a copy of the pamphlet can obtain one gratis on application to the Secretary.

INDIAN SECTION.

Thursday afternoon, February 9, 1899 (at the Imperial Institute); the Right Hon. the EARL OF NORTHBROOK, G.C.S.I., D.C.L., F.R.S., in the chair.

The paper read was—

THE PENAL SYSTEM AT THE ANDAMANS.

BY COL. RICHARD CARNAC TEMPLE, C.I.E.,
Chief Commissioner of the Andaman and Nicobar Islands.

Let me commence my remarks this evening by inflicting on you a little geography. The Andamans form, no doubt, a portion of the earth not very well known: they may be said to be practically unknown, except for one startling and very tragic event, the murder of the Viceroy of India, Lord Mayo, in 1872. So, if any of you have no previous knowledge of the islands, you may fairly consider your ignorance excusable. But that is all the more reason why I should say something to enlighten you this evening.

The territory in my charge, under the Government of India, is known as the Andamans and Nicobars, and consists of a long and narrow string of very numerous islands, running north and south down the middle of the Bay of Bengal. The extreme south of the Nicobar groups is within 100 miles of Sumatra, and the extreme north of the Andaman groups is somewhat further from the coast of Burma. The territory is thus about 600 miles long, and nowhere more than 40 miles wide. The great Penal Settlement of Port Blair, the headquarters of the Administration, is situated the South Andaman Island and somewh about the centre of the whole territory.

It is about this place that I address you t evening, and for my present purpose I m also tell you that the convicts are locat round the shores of a large, land-locked a very beautiful harbour. The choice of t situation is due to the fact that Port Blair 300 miles from the coast of Burma, 400 mil from any part of the Malay Archipelago, a 700 miles from the coast of India, and all th across a stormy and often dangerous se Escape is therefore very difficult. But convic are often desperate people, and escapes ar in rare instances, effected. In every su instance, of course, it is the result of splend courage exhibited in a wrong direction.

The population of Port Blair and neighbou hood consists of the convicts, their guard their descendants, officials, and a small tradi community, and, of the rest of the Andaman of a perfectly harmless, naked race of savag of the Negrito type. The population of th Nicobars consists of a peaceable, jovial tradi community of Malays, who, however, until qui recent times, were dangerous wreckers a pirates. There is nothing of that kind the now, the nuisance having been effectual abated by the settlement of troops and convic in Nancowry Harbour for the 17 years endin with 1889.

I may as well add here that the gre harbours of Port Blair and Port Cornwalli in the Andamans, were first used as sites f Penal Settlements between 1789 and 1796, a that it was in order to check persistent murd and ill-treatment of shipwrecked crews by th Andamanese that the Government of Ind made up its mind in 1856 to try the experime again, the actual commencement thereof bein hastened by the difficulty of dealing with th great number of mutineers, deserters, a rebels that the Government had on its han as the result of the Mutiny of 1857.

Having thus put you in possession of certa information of the necessary sort, I will g direct into my subject, with just the furth preliminary information that the convicts re ceived at the Penal Settlement are the me and women sentenced annually to lifelon imprisonment in India and Burma, and certa others sentenced to very long terms. Th average number present at any given time about 11,000 men and 800 women; say, 12,00 altogether.

Now, the first things that strike one o

ling at Port Blair are the great beauty also the depression of the place, the ible tranquillity and good order there, obviously peaceable demeanour of the vict population, and their equally obvious ire to please the powers that be. But not the visitor be deceived by all this, just as every man and woman of them been the cause of some striking tragedy home, so do these people cause tragedies r the life sentence. Every village and nlet, every barrack and workshop, every ility, almost every nook and corner of Port ir has its ghastly story. It is, indeed, a owful fact that the evil nature will out.

ust let us consider a moment how a convict s to Port Blair. First, there is the tre- ndous excitement of the murder, or the mad rl of the riot or affray, or the sudden heat he gang robbery, or the haunting fear of ection after the great forgery or breach of st, or the horrible misery of the deserted : the very height of tragic excitement, any- . This is followed, in many cases, by the y extremity of excitement that human beings know—the trial for life with all its wild e that perhaps the case will not be proved, haps the death penalty will not be inflicted. s followed further, sometimes, by the despair he death sentence, when, however, hope is by any means dead, for are there not left reprieve, the appeal, the pardon, at least commutation of sentence? But in the end, ether it happen in the dock itself or in the demned cell, there comes that last solemn ment when the convict steps out of the ld he has known, out of the life he has used, out of all the past excitement—into blank future—into the silence of that land ence so few return.

t is when the excitement is over and the g reaction has commenced that, forgotten he world and cast out of society, the convict ses into our charge, a prisoner for the life of generation in any case, with just an even nce that it is for ever.

et us consider now what it is that has ppened to him. Hitherto he has been a man, secured in his freedom by all the hts that his fellow men have created around n for his and their own protection. Now he no rights and knows no law but the orders those in charge of him—he has become a re machine for the obeying of others.

ou will perceive the relative positions of the vict and his master, and what a very serious ponsibility is thus laid on the master, and what I wish to explain this evening is how that responsibility is borne in the Penal Settlement of Port Blair.

Let us begin by some remarks on the convict nature, for so much of his treatment depends on his master's conception thereof; and as a preliminary to these remarks, I wish to say that the Port Blair system has slowly grown up into what it is out of the practical experience of the various superintendents, and the careful orders of the Government of India, based on the consideration of their recommendations. It is no paper constitution, drawn up to suit any particular theories. There have always been the convicts in their thousands, and there have been the climate and the necessity of treating the convicts in the way best calculated to benefit them, and for so employing them as to bring down their cost to the tax-payer to the lowest limits compatible with climatic conditions and beneficial treatment. Trusted agents of the Government have pondered these things on the spot in the light of an ever-increasing experience, and their ideas and suggestions have passed under the criticisms of highly experienced administrators, and have in the end produced the system, which I will now attempt to make clear to you. It would be easy to prove that the Andaman system is the result of the constant attention of the Government which created it, and is the outcome of the measures of practical men, devised to meet the difficulties with which they have found themselves face to face, and reduced to order and rule by some of the keenest intellects that have worked in India for many years past. The very names of some of these who have taken a leading part in building up the system are a guarantee of the administrative ability brought to bear on it: Lord Mayo, Lord Napier of Magdala, Sir Henry Norman, Sir Donald Stewart, Sir Clive Bayley, Sir Charles Lyall, Sir Alfred Lethbridge, Mr. Scarlett Campbell, Dr. Mouat, General Henry Man, General Montague Protheroe, Colonel Cadell.

Now, it is a fair question to ask of any one situated as I am, What is your conception of the convict nature? Wherein do you think that the average convict differs from the average free man? My personal answer to this question from experience is this:—The convict is very like other men, except in one particular—self-control. Want of self-control is the fundamental characteristic of the convict temperament. It comes out in everything that convicts do—it is the root and origin of the

vast majority of their offences against morality and society; it is always present; it must always be looked for and guarded against. There is also, I should add, a certain number of human beings born who are entirely vicious, but such are not very many—not even amongst life convicts. Out of the 12,000 lifers at Port Blair, I regard about 250 as desperately wicked, positively dangerous, and about 250 more as sufficiently bad to make it a common-sense precaution to keep them permanently in a jail. Of the rest the majority are not like this, and can be brought to a considerable height of respectability. Many are not vicious at all, but merely liable to fits of unrestraint.

But I would not be misunderstood here. I do not wish to speak in this place as a theoretical enthusiast, but as a practical administrator, burdened with serious, common-place responsibilities, and bound to take a plain, common-sense view of the subject. I wish to say that, in however kindly a light one may be disposed to look at his case, the clear fact is that the ordinary convict for life is not safe—his liability to lose self-control on quite inadequate provocation should never be lost sight of.

Now, though I have never seen these ideas as to the convict nature officially stated, they are nevertheless those on which our system has instinctively been based, as you will presently see. Port Blair is, roughly speaking, a huge practical reformatory—it contains an organisation labouring steadily for the reform of the criminal. One great factor working for this noble end is that good behaviour of the right kind can of itself commute the life sentence at Port Blair to one of 20 or 25 years, as the case may be.

I will now proceed to explain how we educate the lifer to be fitted to use aright this very great boon—the result, I may say here, chiefly of the combined personal efforts of Sir Donald Stewart, once Chief Commissioner of the Andamans, and of the great Viceroy, who met his reward in the senseless, but typical, murder that has made the Andamans famous.

We commence by placing our newly-arrived convict in the Cellular Jail, by way of breaking him to harness. Here all is discipline. There is no hard work. It is discipline, the sternest of discipline, from morning till night—hard, rigid, uncompromising. We oblige him to bend his rebellious nature to the yoke for six months at least. He remains in his cell all day and all night, excepting the time he spends in exercise in company with ot in the yard outside. In his cell he perfo some light, but useful and suitable work. irksomeness of the discipline is shown in action at exercise. It is not exciting exer exactly, as he has to walk round and round a ring; yet so irksome is that perpetual that he walks round and round the ring hard as he can and impatiently during whole of the allotted time.

Having thus compelled him to submi a severe discipline, we next transfer convict to an Associated Jail, where system is the usual one of hard labour gangs under a strict discipline, and where sleeps in a separate cubicle. Here he st for a year and a half.

He has now gone through two years, for the next three he is employed as a sl That is, he sleeps in barracks, locked up other slaves, and works hard all day u supervision—an unpaid, unrewarded labou but well-fed, housed, and cared for, and alw under watch and guard.

Five years have now passed and the seve of the life is eased down a little. The ta are not so irksome, the employment is varied, personal capacities are more stud the capable are eligible for petty posts supervision, and so on. The convict now gets a very small allowance, with wh he may buy little luxuries for himself, or if chooses, he may place it in the Savings Ba an educating institution I will later on expl

This condition lasts until 10 years are c pleted. Many a lifer has now served half time, and if he shows that he has the capa to support himself, and if we have suffic grounds for trusting him, we grant him a l ticket-of-leave. He cannot, however, le the Settlement, and is still a convict. At Blair he is called a self-supporter.

The convict is thus at last in a sense free. earns his living in his own chosen way; lives in a village in his own house; he farm little land; he keeps cattle; he can m about unwatched; he can send for wife children, or, the far more frequent course can marry a convict woman, who under own regulations is eligible for marriage; can thus become *pater familias*, with a l hoard of his own earning, and differing wardly in no way from the ordinary village properly conducted member of human soci In reality, however, he differs so greatly he misses all those things that "free" prize so highly. He has no civil rights u

ordinary law, and all the affairs of his life dealt with by the executive authority; he : live where he is told; and generally uct his life as he is told; he may move it beyond his village and his fields by iission only; he cannot leave the Settle- t; he may not be idle under pain of a ed return to ordinary labour. In this state emains 10 or 15 years, according to the es that have sent him to prison, until the py day arrives when the order for absolute ise is placed in his hands and he goes free ther men.

s in the other portions of his life in trans- ation, even in the condition of self-support, convict passes through two distinct stages. ie first stage he is assisted at the beginning house, food and tools, and then by ex- tion from rent, taxes, fees, and other es, payable by the free towards the mon benefit. In the second stage he ives no assistance whatever, but finds the le of his means of livelihood, and is rged with every public payment, which ld be exacted from him in his own country. he women are dealt with on the same lines, more gently, as becomes the gentler sex. the first three years the convict woman ks in the female jail as a mere slave, fed, sed, clothed, and cared for. Then for the t two years she is treated to the same sort asing of severity as is granted to the men, after a total of five years she becomes ible for marriage and domestic service. uming that she marries, she joins her band in his village, where she leads the inary life of an Indian woman, but subject he same disabilities as her husband, until has completed 15 years in transportation, en she may go free with him, whithersoever may go.

Now, through all this long education to ful citizenship there run continuous threads practice in self-help and self-restraint, and inducement to profit by the practice. The gth of the convict's stay in the Cellular Jail pends entirely on his conduct in it, and so it nains throughout his career to the point of f-support. Effort to behave well and sub- ssion to control mean promotion upwards m grade to grade in due course. Every ious relapse means the retarding of pro- tion, or actual retrogression. And when he s obtained his ticket-of-leave it is to his own ort, his own thrift, his own steadiness, that has solely to look for that little hoard, which to be so much to him when he goes back to his native land—no pauper, no mere jail-bird, no unwelcome burden on his relatives—but a self-respecting citizen, with a little capital of his own earning, for years habituated to provide for himself in an orderly way, and thoroughly broken to harness, as it were.

It does not require much imagination to contrast the difference in the personality of the same human being as he reaches and leaves Port Blair. He that arrived an outcast, void of restraint, and unfit for association with his kind on equal terms, goes forth a useful citizen, broken to restraint, and not only fitted for human society, but well used to submit to the conventions by which alone that society can be maintained. And men so reformed are not sent back to India by ones and twos, but by scores every year. The incorrigible are kept till death, and the slow to learn are kept till they mend their ways, while those only that have good in them and are capable of reform are returned to the society they once disgraced.

You will have perceived from what I have just said, that the Port Blair system is one of continuous education in self-restraint. It instinctively assumes, as I said at the outset, that the distinctive feature of the convict temperament is want of self-restraint. The Penal Settlement is a reformatory in practical result.

Now, the special difference between the result of the Settlement system and that of the ordinary jails appears to lie in this: while the Port Blair returned convict is a man fitted and habituated to support himself, the prisoner released from a jail is not only a pauper, but has become pauperised. That is, he has become unaccustomed to find for himself, and this disability has grown upon him with the length of his imprisonment. At Port Blair we do not part with a life convict until we believe that there is a reasonable hope of his living the rest of his life at home in an ordinary, orderly way.

So far we have been considering the direct personal education that the convict receives at Port Blair, but besides this he is taught various lessons of general importance in indirect ways. There is the value of justice, for instance. For though his life is absolutely controlled by executive officers, everything that happens to him is the result of a quasi-judicial procedure. No punishment can be inflicted without a proceeding, without registration, or without record of the evidence on which it is awarded. There is a regular course of appeal, and a further untrammelled appeal to the head

of the Administration himself. Thus, though the punishments in such a place as Port Blair must on occasion assume a form of deterrent severity, there is as much security of justice in award as elsewhere. You will see the importance of this, and that it regulates the relation between the convict and those over him.

Then there is the system of local marriages, about which I wish to speak a few words, as it is so frequently and persistently misunderstood; the same old misrepresentations being regularly reproduced for the public about every ten years or so, partly by the facetiously mischievous, and partly by the ill-informed, though well-intentioned. I wish to explain clearly that a local convict marriage is no concubinage, no temporary or irregular alliance. Every enquiry is made and every step is taken that is necessary to render convict marriages legal, according to the customary personal law of the contracting parties. Long is the waiting in many cases between proposal and completion, and many are the disappointments, when the conditions are found to bar completion. Once married, the husband and wife are clearly made to realise their legal condition, and must depart together or not at all. The practice in regard to these marriages in my own time is, I believe, that of every one of my predecessors; namely, the Chief Commissioner personally enquires into each case, and then sanctions each marriage himself, for without such sanction no convict marriage can take place. Finally, when a marriage has taken place after sanction, the Chief Commissioner registers it himself, and thus completes the precautions necessary for its legality.

The children are, of course, a very serious question, but the best is done by them. Their health is so well cared for that in Port Blair, probably alone in all the East, it is the rule to successfully rear the whole of a young family; primary education is there compulsory, again probably alone in all the East; and technical training is free to all. Their inheritance of temperament and their early associations are the points of anxiety regarding them, and these matters may be fairly said to be beyond control.

I have already mentioned the Port Blair Savings Bank as a factor in the education of the convict. How great has been the effect of this truly beneficent institution will be seen from the fact that for years past more than a fourth of the resident convicts have kept their savings in it; first, out of their little allowances, and then out of the earnings of their holdings. They have thus shown how well they h[ave] taken to heart the two great lessons of th[rift] and of faith in the honesty in the Governm[ent].

I must also mention the hospitals and [the] great good they do. Every convict, whet[her] in the labouring or in the self-support[ing] classes, has care in sickness, as it were, th[rust] upon him. He is taught to look to the do[ctor] as his friend, and it is a great pleasure to [be] able to testify here, as I have often done bef[ore], to the humanity and good sense with wh[ich] the medical officers of the Settlement perf[orm] their duties. The proof of the pudding is [in] the eating. The death and sick rate at P[ort] Blair are, for the East, exceptionally lo[w]. The sanitation is the best I have seen in [the] East, after an unusually wide experience, a[nd] the result is what?—We have no cholera, [no] small-pox, no malignant epidemics.

The picture I have thus drawn for you [is] undoubtedly open to criticism as being op[ti]mistic. But I would remind you that yo[ur] attention has been more than once dra[wn] already to the fact that there is a seamy s[ide] to life in Port Blair. It could not be otherwi[se]. Life convicts are not an honourable nor scrupulous class; they are not ladies a[nd] gentlemen; their manners are not mild nor a[re] their impulses repressed. Life and limb, [in] fact, are by no means secure in Port Blair, a[nd] if I were to lay myself out to describe to you t[he] life in a convict village, or in convict barrac[ks] as I only too well know it to be, and the conditi[on] of perpetual irritation in which convicts li[ve] arising out of their own mutual ill-will and d[is]trust, I could easily send you home as miserab[le] as the veriest pessimist could desire. Ho[w]ever, instead of doing this, I have hoped rather [to] have impressed on you, that we, who have [to] deal with the convicts, look on them as phy[si]cians do on their patients. We cannot h[elp] the existence of the disease, but we try [to] diagnose it correctly, alleviating where we c[an] and curing where we can, but not laying a[ny] claim to the working of miracles.

It would, indeed, be easy enough for me [to] paint a lurid picture of the inhabitants of t[he] Penal Settlement, easy enough to preach [a] scathing condemnation of the envy, hatre[d] and malice, the uncharitableness, the ev[il] speaking, lying and slandering, the murd[er] and the cruel death, of the amazing immoralit[y], the callous depravity, the downright, unabash[ed] wickedness, that are so constantly forced up[on] my view. But such is not my purpose. Hum[an] faults are easily seen and easily denounced, f[or] such things lie on the surface. The difficu[lty]

ıg always is to perceive aright the good t there is in bad men, and bring that out. that is what we officials are sent to Port ir for; that is our duty and the object that Government is aiming at in the system just plained.

Now, a question that has been asked of me, l it is a natural one, is: What do you do h all those men and women? It is not ily answered, because Port Blair comprises tself a separate community of human beings, h practically only one source of labour, the ıvict. The convicts, therefore, do anything t the labourers of a whole community do. d in this way, though there are on the daily our books between 8,000 and 9,000 hands a y, every one of whom has a definite task otted him, there are—though this may seem be a paradox—not enough for the work to done. The work has, indeed, to be carey allotted throughout the year, so that it y be all accomplished.

But here are some of the things that the ıvicts do in various directions:—They clear ests, drain swamps, reclaim coral banks, l make out of them grazing and arable ıds. They do all the cultivation and grow the food and fodder—cereals, fruit, vegebles, tea, coffee, cocoa, tapioca, arrowroot, pper, oil, and so on. Jerusalem artichokes grown by the acre. They also catch the ı required. They prepare and cook all the d, and make all the kitchen utensils, pots d pans. They breed and tend the cattle, eep, pigs, and poultry; the success in sheepeding has formed a new departure in such itters in the damper portions of the tropics; y take out the fuel of the forests and it up; they make the salt from seater. They do the porterage and all the carge, whether in boats, barges, tramways, carts. ey build all these things—anything from a am-launch to a wheelbarrow, or any kind of niture. Carvel-built boats are a speciality. ey provide the materials for what they make wood out of the forests and ironwork out of g-iron. They build and construct every blic and private work in stone, brick, wood, n—the fine barracks, and the huge jails, the utiful church, the factories, mills, houses, l chimnies, the long sea-walls and piers, harbour breakwaters, the roads and drains, earthworks and embankments, the reserrs and wells. They provide all the materials ime and mortar from the coral banks, stone m the quarries, bricks and tiles from local ıy. They cut timber in the forests and prepare it in the mills. They manufacture and make up all the iron, brass, copper, and other metal work. They do the plumbing, glazing, and painting required, both for vessels and buildings. They make rope, yarn, string, and fishing-nets trom the hemp and cocoanuts they themselves grow. They make cane and wicker and basket-work from the canes and bamboos of the forests, which they fetch. They, *i.e.*, chiefly the women, make all the clothing and bedding, cotton, woollen, cloth, and leather; tanning the skins of their own cattle, spinning the cotton from the rough hank, cleaning and spinning the wool as it comes from the sheep's back; their sheeting, towelling and cotton carpeting is stout and unusually good.

They drive and run a great mass of machinery — steamers, engines, saw-mills, brick-mills, rice and flour mills, water-works, huge steam workshops. And were it not for the machinery, the work we have to do would never be got through. They do other work of a superior sort, such as port-signalling, tide-gauging, meteorological reporting and designing of many kinds. Some of the wood-carving, hammered brass and iron work, fine wicker and basket work is excellent.

They do nearly all the domestic and messenger service, all the washing, scavenging, and cleansing, and all the petty supervision of the work. They do much of the clerical, account, and statistical work, too, and all the printing, lithographing, and stereotyping.

This is something of what the convicts do, and you will begin to perceive why it is that the Superintendent is often put to it to find labour for what has to be done. The object of employing the convicts thus is to save the taxpayers' pockets, to make the cost of keeping the useless of their kind out of their way as small as is reasonably possible. We interfere with no trade and we compete with no honest labour. What we aim at is to find for ourselves with as little expenditure in cash as we can manage.

The question just answered raises another: How do you manage all this? Who are your experts? Well, we have hardly any experts. The officers and their subordinates have first had to learn what is wanted as best they could, and then to teach that very bad and unpromising pupil, the convict.

What a mighty and endless task this is you may gather from the facts, that only about three per cent. of the convicts at Port Blair can be employed at the occupations they are supposed to have pursued before transportation,

and that casualties among convict artificers are constantly occurring, owing to release, promotion to self-support, or punishment for serious misbehaviour. There is no end to this. I remember once losing the services of the leading men in the printing, lithographing, and stereotyping establishments in one moment, because these worthies were found employing the metal supplied them in stereotyping rupees instead of printed formes. The present chief designer of carpentry work is a born artist, but spends half his time beating cocoanuts in jail, because of his inability to behave decently for more than six months at a time. The finest accountant we had passed his last years in a very ignoble way, owing to his habit of ingeniously cooking his accounts. Another man I remember, a house painter, with as neat and certain a hand as one could wish even at the finest work, had suddenly to change his occupation, being unable to resist the temptation of trying to sell the materials supplied him. And so it goes on always.

The Superintendent's duty is to watch, direct, and order, and the duty of those under him is to carry out the orders intelligently. It is to the intelligence, loyalty and honesty of the executive and subordinate officers that what may be fairly called, in spite of all drawbacks, the satisfactory condition of Port Blair is so largely due. Their work indeed proves once more what is to me a favourite theme—Put the average Englishman on his metal and he will do anything.

Now, I need hardly say that my official position precludes me from making any remark on the merits of the system I have described. I can only describe it, and in doing so I expressly wish to draw no comparisons; remembering that what is suited to India and the Indian peoples is not necessarily suited to, say, England and the English.

The only general opinion I will venture is this. Were I asked to give advice to a novice in the treatment of convicts, I would say to him: Remember that the convict is a born rebel, without self-control or right impulses; therefore, if you would succeed with him and lead him on to orderly ways, be firm without favour; never forgive him a fault, but never punish him vindictively.

Having thus described to you the system at Port Blair, I now propose to give you some small idea of the place itself by the aid of a series of slides, some of which are prepared from photographs supplied by Mr. E. H. Man, C.I.E., Deputy-Superintendent of the Andamans.

I commence with a general view of the inn harbour of Port Blair, taken from the low western slopes of Mount Harriet, which w so named after the wife of General Tytler, on Superintendent of Port Blair. The view giv some idea of the great natural beauty of t Andamans. The whole of the islands ar indeed, surprisingly beautiful, and, fortunate for the residents, are so studded with roon and safe harbours, that one can get about in a kind of weather. I have, of course, been ever where and all over them repeatedly, and an thing but a beautiful scene is hardly anywhe to be met with. In the distance of the view a Viper and Chatham Islands, situated inside t harbour. On the former is Viper Jail, whe the very worst criminals in all India are mo or less permanently confined; and on the latt are the great saw-mills, in which is cut up ar prepared the export timber, the chief source actual revenue to the local government, and t existence of which greatly reduces the cost the convict to the public.

I now give a view of South Corbyn's Cov which shows many little points relating to t Penal Settlement. Mr. Corbyn was on chaplain there. In the foreground is a spec men of the beautiful and often exquisi Andaman jungle; and also of a creek, *i.e.*, salt-water estuary of one of the small rivers the Settlement. These are almost always great beauty. The view also shows a road ar embankment, and behind them rice-fields, a reclaimed from the creek by convicts. An in the background, on a small hill, is Corbyn Cove Village, inhabited by self-supporters ar ex-convicts. I have not mentioned the latt so far. The ex-convict is the man who, c his release, desires to remain in the Settleme and to earn his living there as a free man, who returns to the Settlement of his own acco after he has obtained his release and lived f a while in India. This class is much e couraged, though many do not avail ther selves of the privilege, so great is the love home in the native breast—perhaps strong there than among any other peoples on t earth.

Next comes a view of Aberdeen Harbou Here is shown a cocoanut grove, planted in reclamation from the sea. Cocoanuts are n indigenous to the Andamans, and though th are already producing an appreciable incom every tree has had to be planted and special cared for. The seed nuts have all come fro the Nicobars, where the tree was, even in t days of I-Tsing, the Chinese traveller of t

century A.D., the staple source of liveli-l, as it still is. Here again are roads and ankments and a tank or reservoir. Here is a small harbour of safety for open boats barges, with two long solid stone piers osing it. The whole of the works above ribed were brought into existence by ict labour. The name Aberdeen is in-sting. For some reason, perhaps, because r, the great Indian marine surveyor of the century and eponym of the place, came 1 Aberdeen, there are several places about t Blair named after that neighbourhood—, the lunatic and leper asylums, and one he great hospitals of the Settlement are ated at Haddo.

[ere is a view of Chatham Island from ddo, exhibiting the saw-mills and invalids' king-shed. All the invalids and infirm victs, able to do some work, are settled on island, where they make baskets and string, l do such like sedentary and light work. e view also shows a signal station, which is eresting. Out of the necessities of the case arisen a very complete system of sema-phing at Port Blair—*i.e.*, of signalling at time and in any weather by means of gs, heliograph, or night-lamps, worked by military police force of the Settlement from and to island and from point to point. The ms are ordinary telegraph forms, and there a charge per word, as in ordinary tele-aphy, for private messages. The system is so nplete that the Superintendent can have in hands an answer to a circular message m every semagraph station in the Settle-nt within half an hour of its despatch. He n thus know in a very short time, in any cessary detail, what is going on generally at y hour of the day or night.

I now show three views of Viper Island, so med after a Royal Naval gun-boat of the st century. This island contains chiefly the ol for the very bad characters already entioned, and its accessories. On it is also uated the picturesque building where once ere kept the European convicts, but there have en none confined there for 30 years. The ettlement is not really suited to them. The ilding is now used as a signal station and tive police guard-house, and is in reality on a parate island, called Buknipur; but long ago e two islands of Viper and Buknipur were ined by the reclamation scheme, which gave e only piece of flat land thereabouts. I ay notice here that at Port Blair re-amation from the sea is not only of economic but also of sanitary value, as it is usually carried out over a coral bank or mangrove swamp. Neither, especially the former, can be made healthy, except by being covered over with fresh wholesome soil from the neighbouring hills to a point well above tide-level. The views also show another point of interest—the boat harbour of Viper Island, made by means of a breakwater with a very narrow entrance close to a sentry-box, from which it is brightly lighted. As all up-harbour boats have to be counted into this harbour every evening, this makes it difficult for boat-escapes on the part of the most desperate convicts in the Settlement. Every boat has also loose brass rowlocks, which have to be delivered up to the police sentry on duty at the entrance all the while a boat is lying in the harbour. This gives some notion of the con-stant state of precaution in which the officials of the Settlement live. Opposite Viper to the west is Navy Bay, so called because of its depth and size. It is five miles from the open sea, and round the corner from the entrance of the main harbour, but is still capable of holding deep draught vessels in some numbers.

I now pass on to Ross Island, the head-quarters, which shuts in the outer harbour from the sea: chosen for the head-quarters because it is nearest the open sea of all the islands in the general harbour, and so every boat must pass it to get out, and because on it can be safely kept the spare food supply, the records, and the small amount of money necessary to finance the place, out of the way of any rising or attack. Supposing the convicts to rise, they would be easily starved into sub-mission in a very short time. On it are Govern-ment-house, the British infantry barracks, the church, the Settlement mess-house, the local volunteer head-quarters, and other large build-ings; all fine examples of what convicts can be made to do. The church has a fine stone spire, all convict work, designed by General Man, while Superintendent, and subsequently constructed under Col. Horsford, Chief Com-missioner, and myself, as a memorial to the only too-numerous Europeans who lost their lives in the great cyclone of 1891. The barracks, as you perceive, are a handsome castellated building in dark grey sandstone, entirely constructed by convicts. The views also show the ice-house, where solid ice—a matter of life itself often in the moist tropics—is artificially made daily by the ton.

Some of the views on Ross Island will show

you convict life and work. Here they are feeding in the appointed place, all in the open, be it observed, without a single free guard of any kind present. All the men with belts are warders, but every man of them is himself a convict. This shows something of local methods and system. Here is Ross Harbour, with its steam launches and boats; another example of convict activity, for every boat and barge there has been built by the convicts. In the foreground are some bad characters in light chains hauling in a log for boat-building, with only a convict guard and no free man over them. Here is Ross Bazaar, where only free people live. The people in the lively street shown are all free—traders, native soldiers in plain clothes, police—with only a convict warder here and there off duty, to show that we are in a Penal Settlement.

I also give three slides of Government-house, because it so well exhibits convict labour and work of the superior mechanical sort. The building, as it now stands, was re-planned and re-constructed by myself from my own plans. It is a many gabled design of the old English type, adapted to tropical needs, and was constructed roughly thus: I drew a ground plan and elevation in single line to the scale of an inch to a foot, and with these and nothing else—no working plans whatever, excepting a few rough detailed drawings as required from time to time—one of the locally-trained foremen-builders in wood, a carpenter by trade, and an ex-captain of banditti by occupation, constructed the large elaborate building you see, with the help of personal explanations from time to time. The building is the joint work of myself as architect, a trained Government Public Works Supervisor to draw up specifications and superintend, and a convict as builder and technical constructor.

The ground floor also shows something of our methods. The old floor was too low and the old building, every stick of which has been preserved (for reasons of economy) that could be used, was too much injured by time and the cyclone to stand underpinning and lifting; so, in order to get height, the ground on which it stood, the apex of a hill, was cut away from under it and round it, bit by bit, until the required height was secured. The new hill slopes thus made necessary were constructed by myself with the aid of a local genius, whose occupation at home had been that of scavenger, but who under us became an experienced and most expert foreman for earthwork of all sorts. There were no plans used; there were only the laying down of lengths of string and ve[...] instructions.

The interior view of the building shows [...] great staircase and the painted frieze of [...] hall, and also the carved doors and o[...] carved wooden screen of the ball-ro[...] Elaborate as all these are, they are all con[...] work from local designs, the carvings be[...] from the design of the Burmese convicts th[...] selves. The painted frieze is by a locally trai[...] painter, who in his free days had kept [...] oilman's shop, but who can now paint, as [...] see, from paper stencils cut to full size [...] myself.

The ornamental stone balustrade in front [...] the house is convict work made from h[...] local grey sandstone, which is first roug[...] fashioned into the form required and t[...] turned on a steam lathe used in turning me[...] The difference in working is this: The la[...] for metal work is sent round at a great spe[...] but for stone work it must turn very slowly, [...] either the stone or the chisels will chip. Ab[...] two-and-a-half stones were turned per diem.

I now show a copy of the scene of L[...] Mayo's murder made by Major Jervois at [...] time and on the spot.

Lastly, there are three views exhibiti[...] Andamanese life and ways. The first is [...] fine *mahwa* jungle in the North Senti[...] Island, about 60 miles from Port Blair, wh[...] are to be found some of the Jarawa tribe [...] the Andamanese, who are still and alwa[...] have been, entirely irreclaimable, neit[...] kindness nor force having had as yet a[...] appreciable effect on their repugnance [...] strangers of any kind, even of their o[...] Andamanese neighbours of other tribes. W[...] every other tribe we are on the most frien[...] terms. The other two views show t[...] Andamanese spearing and shooting fi[...] before our advent their chief and often o[...] source of food, and making canoes out of lo[...]

DISCUSSION.

The CHAIRMAN said, on hearing this paper r[...] and seeing the views, his mind was irresistibly brou[...] back to the tragical event to which the lecturer [...] alluded at the beginning of his paper, and he felt s[...] that there must be several present whose memo[...] had also been recalled to that sad event. Lord M[...] seemed to have been, from his commanding presen[...] his genial manners, and his generous nature, mark[...] out to be a ruler of men. When he came [...]

, he said in one of his first utterances there, he was confident, with God's help, he would be to devote himself to the interests and welfare of illions put under his charge. There never was timent more thoroughly realised than that by areer while Governor-General. A very few s before his death he had to deal with a very ult subject, in which the generosity of his nature ared in the most prominent way. He would not e to it further than by saying that he wrote a r to the Duke of Argyll, who was then Secretary tate, giving his views upon it. That letter was lated to the Cabinet, and was afterwards comicated to him (the Chairman) for his information, on that letter Mr. Gladstone had written, in his hand, "a noble relic." The devotion with which l Mayo was served by those under him was well wn, and the affection which he inspired, amongst native princes of India, was very remarkable. He remembered having had a conversation with Maharaja of Jeypore, one of the most lligent of them about Lord Mayo, and he could that it was with great difficulty that he could rain his tears. Those who followed him knew er than anybody else how well he performed duties of his high office, and no one could better reciate this than he did, for he felt, with his much rior qualifications, how difficult a task he had in eavouring to follow Lord Mayo's footsteps. He ld not refrain from this short notice of the event tioned at the beginning of Colonel Temple's er, and he would add that the most careful investions were made after the catastrophe, and it was rtained beyond doubt that no fault could be attrid to anyone who was responsible for the safety of Viceroy on that occasion. Moreover, although re were at the time suspicions that there might e been some political conspiracy at the bottom of crime, it was found on inquiry that that was the circumstances absolutely impossible. At the e time, that tragic event led to an observation ch was connected with this penal colony, namely, extraordinary contrast shown between Western s and civilisation, and the customs of many of se with whom we had to deal in the East, and who l hardly emerged from a primitive condition of iety. The assassin, Shere Ali, was a very brave n belonging to one of the Afridi tribes who l done excellent service to several Commissioners at hawar, and distinguished himself as a soldier. He s entirely trusted by Colonel Reynolds Taylor, one the best of our Indian officers, when at shawar, and he used to go about with his children, l, in fact, was the confidential servant of house. This man, however, belonged to a iety in which tribal feuds were a hereditary custom. ere was such a feud in his family, and he was led upon to take his part in avenging his side in quarrel. If this man had committed the murder the other side of the frontier no notice could have en taken of it, and it would have been considered by everyone connected with him as only a proper thing for him to have done under the circumstances in accordance with the religious feelings and customs of the tribe; but as he committed the crime near the cantonments of Peshawar it was necessary that he should be tried by English laws. He was tried and sentenced, and it was supposed at the time that it was a privilege to send him to the Andaman Islands instead of inflicting the sentence of death. The man himself, however, desired to be put to death rather than be sent there; he thought himself unjustly treated, and took the first opportunity he had of revenge. He knew of another case of the same kind equally striking in connection with one of the tribes in the centre of Bengal. A man came home to his house after being away for a time and found his house burnt, his cattle were all driven away and his wife with them. He followed the robber, caught him up, and with a bow and arrow shot him dead on the spot. Here again, according to English law, was a murder, but it was not a murder according to the views of the tribe to which he belonged. That man was afterwards pardoned. That showed the difficulties with which they had to contend in India, and how different the cases of crime were in that country from those which occurred in England. He would not attempt to express any opinion with regard to the management of the penal settlement; they had heard Colonel Temple's account of it, and there were others present who could speak of it with much more knowledge than he possessed, but he might say, with regard to the paper, that he heard it with very great pleasure, and congratulated the author on having inherited those qualities of graphic description which his father so eminently possessed.

General Sir HENRY W. NORMAN, G.C.B., G.C.M.G., C.I.E., said he had heard, with great regret, that Sir Donald Stewart was not able to be present that afternoon, as he could have told them a great deal about the Andamans, where he was for several years, and many great improvements were carried out during his residence. He himself could tell them but little, as he was there but a short time, some twenty-five years ago, when he was sent there by Lord Northbrook. After the lamentable occurrence of Lord Mayo's assassination, Lord Napier and Ettrick, the acting Viceroy, sent down Mr. John Starlett Campbell to inquire into all the circumstances, and to make any suggestions he thought desirable with respect to the organisation of the settlement. Mr. Campbell sent in a very full and valuable report which came under the consideration of the Government of India after Lord Northbrook's arrival. Some references had to be made to the settlement, and eventually he was desired to go down and report on certain doubtful matters, and to make any suggestion that he thought proper. He need not enter into any of the points with which he dealt, which would not interest the audience, but after conference

with Sir Donald Stewart, he came to the conclusion that certainly one important measure should be adopted, and it was that every convict should have the prospect of returning to India, after, however, a long period of penal servitude, if he continued to behave well. That view was not taken by everyone; some thought that those who went there should remain for life, the great majority at any rate being life sentences, but it seemed to him that if they extinguished the hope which all persons sent from India had of returning to their own country, they would simply be made desperate. They had heard from Colonel Temple that even now there were a certain number of that character, and, he believed, that number would have been much increased if all hopes of returning to their own country were removed. He, therefore, urged that a regulation should be drawn up, under which, after many years' good conduct, it should be possible for a convict to return home. Lord Northbrook took the same view, and that was carried out, and he believed with good results. Even in those days he was much struck with the excellent arrangements made in all departments. With regard to the medical department, the hospitals were admirably conducted, and great efforts were made by the principal medical officers, though they had not been attended with complete success, to cure leprosy, because amongst so many convicts from India there were certain to be some lepers. At one time it was thought that the administration of gurjun oil would eradicate the disease, but although it had greatly improved the condition of the patient, and had been introduced into Jamaica and other places, and was used with great effect, he was afraid in no instance had it effected a complete cure. Some years afterwards he found himself pretty near the great French penal settlement of New Caledonia, where there were not quite so many convicts as at Port Blair —only about 10,000. At Port Blair the convicts were kept quite securely with a small military force, one company of European soldiers and four of natives, but in New Caledonia there were two complete battalions of French infantry, a company of artillery, and a number of European warders. He was not inclined to think that the management at Port Blair could be much improved by any hints derived from New Caledonia, but it would be interesting if someone well acquainted with the Andamans could visit New Caledonia, and make a comparison between the two systems. In one respect the convicts very much resembled each other, namely, in their desire to escape. New Caledonia was about 700 miles from Queensland at the nearest point, much farther than Port Blair was from Burma or the coast of India, and the sea between New Caledonia and Australia was as dangerous as that in the Bay of Bengal, but still incessant efforts were made to escape. In one year, he believed, 48 French convicts reached the shores of Queensland and considering the frail boats and canoes in which they got away, he should think at least as many must h[ave] been drowned on the way. These convicts alm[ost] invariably fell into the hands of the Queensland po[lice] immediately on landing, and under the extradi[tion] treaty they were soon sent back, and, according [to] the French system, they got an extra number of ye[ars'] imprisonment. Under that system they added t[o a] man's term quite irrespective of the length of hu[man] life, and he found that one or two convicts, who [had] been in Queensland, had already earned more t[han] 100 years' imprisonment. He was sure they were [all] much indebted to Colonel Temple for the informa[tion] he had given them in regard to what was, he belie[ved], the greatest penal settlement in the world.

Sir CHARLES JAMES LYALL, K.C.S.I., C.I[.E.], said he could do very little more than enforce [the] lessons which Colonel Temple had put before th[em]. He visited Port Blair some nine years ago at [the] request of the Government of India to report on [the] system in force at the time, when Sir Alfred L[e]bridge, a most experienced gaol officer, was his co[m]panion, and their visit was made because some[one] suggested that transportation had lost its terrors [for] the Indian criminal, and that the system of discip[line] required bracing up and strengthening. Their con[clu]sions were that a great misconception had prevailed, [and] that any loss of terror which there might be was [due] chiefly to the custom of sending term convicts th[ere], who returned after four or five years' transporta[tion] and told their friends at home that the place [was] very comfortable, that people lived there in villa[ges] and grew crops, and did not appear to suffer f[rom] any great severity. At their suggestion [the] practice of sending short term convicts [was] stopped, and now, with the exception of Burma, all convicts sent there were life convicts. P[ort] Blair was not only one of the most important pe[nal] settlements in the British Empire, but perhaps [the] only place where a reforming discipline was brou[ght] to bear upon the criminal. He was much struck by [a] passage in the paper in which the author spoke o[f a] convict discharged from an ordinary gaol as be[ing] "pauperised," by which he meant that he was depri[ved] of those methods of fighting the battle of life w[hich] the natural man possessed. He had been loo[ked] after for so many years by the State that he [was] deprived of all self-reliance, and the result was [that] our gaols were crowded with recidivists – men who [had] been convicted time after time. Port Blair wa[s a] great contrast to that. The system there began w[ith] severe discipline, the bonds of which were gradu[ally] relaxed on good conduct; when the twenty ye[ars'] period was half through the convict was m[ade] in some respects a free man; he was started to [earn] his own livelihood, and assisted by the State [in] growing his crops and building his house, and l[ived] with his friends or his wife, and became aga[in a] respectable member of society. One of the rec[om]mendations he and his colleague made was [a] greater resort should be had to the penalty

[tran]sportation by courts in India, so that in place [of t]hose melancholy failures which habitual criminals [pres]ented in Indian gaols as they did in Eng[land] —men convicted time after time, who never [impr]oved or made any effort to retrieve their [posi]tion—they should be sent to Port Blair. There [was] a section in the Penal code which enabled [this] to be done, and the report of those who [drew] up that code recommended that it should be [don]e. Unfortunately, their recommendation did [not] find favour with the judicial authorities. The [phra]se "transportation for life" seemed so terrible that [they] were unable to advise the sessional courts, which [had] to deal with these crimes, to impose so terrible a [pen]alty, when what seemed a milder penalty of [seve]n or ten years imprisonment might be [give]n instead, and so this opportunity of reclamation [was] lost. He hoped Colonel Temple might be [per]suaded at some future time to give some [furt]her information about this extremely interest[ing] colony. The Andaman Islands were not only [inte]resting as a convict settlement, but they were [one] of the most remarkable parts of the globe from [a sc]ientific point of view, and it would be very useful [to] learn something about their geology and their [flor]a and fauna.

[M]r. WILLIAM TALLACK (Secretary, Howard [As]sociation) said many present must have been [ple]asantly reminded by this paper of the interesting [boo]ks which Colonel Temple's honoured father had [wri]tten on India and Palestine. Colonel Temple [ha]d taken an assured position amongst those able [Ind]ian administrators whose services the noble [Ch]airman had already alluded to; but there was one [na]me mentioned in the paper which was particularly [int]eresting to himself, as being an old friend of the [Ho]ward Association, and one with whom he had had [the] pleasure of conversing on many occasions. He [ref]erred to Dr. Mouat, who was the principal [fou]nder of the work in the Andamans. He well [rem]embered him as one of the most genial, as well as [one] of the ablest, of men. He was at the [Lo]ndon International Prison Congress in 1872 [and] again at the Stockholm Congress in 1878, [and] on each occasion his geniality and encyclo[pe]dic information rendered him one of the most [im]portant persons present at those gatherings. [W]hen he took over the superintendence of the [pri]sons of Bengal in 1855, about two years before [the] Mutiny, he was told by the then Inspector that he [ha]d found them in such a state of irregularity and [co]nfusion that he had given up all attempts to set [the]m right, and simply handed over the task to [Dr]. Mouat. He set to work vigorously, and it was [to] him especially that they were indebted for the [ca]rrying into practice the operation of the great [pri]nciple of reformation, and especially reformation [by] remunerative industrial labour. He made that [the] most prominent matter in the Indian prisons, not [me]rely in the Andamans but in the prisons on the mainland, and he had had many excellent successors and imitators in that matter. He (Mr. Tallack) believed the system of varied and useful industry was carried farther in the Andamans than in any other penal establishment in India, and possibly than in any other place in the world. The practical point which impressed itself most on his mind was that the example set by the administration of the Andaman penal settlement pointed to a matter in which England particularly needed to make progress, and that was not only to aim at reformation but to take the necessary time for the formation of good habits and the eradication of bad ones. That required time, a thing which was overlooked by the public, and by many public writers. A great deal of fault had been found lately with English prison systems, because a majority of the prisoners were recidivists, who came back again and again, showing they were not reformed. It must be borne in mind that only one in fifty of English prisoners were detained more than six months, and about three-fourths of them were only in from a fortnight to a month. What reformation could you make in a few days, or a few weeks? How could inveterate habits of drunkenness or vice be eradicated in so short a time? The very idea was absurd. In the Andamans they had years to do it in, and not only so, but before the actual period of penal servitude was over, there was an intermediate stage, which was also a part of Dr. Mouat's plan. The convicts were then allowed to marry, which was a very important thing in connection with their reformation. They were encouraged to save, and in various ways were assisted to form habits which were necessary for their getting on in ordinary life. In this country, some reforms had been made of recent years, and any one who knew the present condition of the prison service knew there were excellent men both in the higher and lower departments, but we had not adopted the plan of testing the reform before releasing the prisoners. If a man were found unsuitable for liberty, if there was every probability that when he was let out he would commit murder, or again become a burglar, he ought not to be set at liberty. It was not absolutely necessary to have long sentences, but it was necessary that the detention should be long enough to form good habits. In the best American prisons they were increasingly aiming at reformation, especially in New York, Massachusetts, Illinois, and Ohio. There, generally speaking, the terms were too short, but, considering the short terms, they had had some remarkable successes. He should add that in the United States there were also some of the worst gaols in the world, and no words could sufficiently describe the evils of the convict leasing-out system which prevailed in some of the Southern States. They were much indebted to Colonel Temple for this paper, and also to the illustrious Administrator who had occupied the chair.

The Rev. Dr. W. DOUGLAS MORRISON (late

Assistant-Chaplain at Wandsworth Prison) said he wished to join in congratulating Colonel Temple on this admirable paper. He had read a great deal of prison literature, but he did not think he ever came across so much information in so small a compass as they had had that afternoon. He was much struck with the remark on the conditions which produced the criminal population. In a great number of cases the criminal was the product of what might be called his individual conditions and characteristics, but he felt sure also that the criminal population, especially in this country, was to a great extent the product of evil social conditions. If an individual had no chances in the world, if he were born and bred in the midst of the deepest misery of every kind, how could you possibly expect him to be anything else in the end but a criminal. He had seen hundreds and thousands of cases of that kind. No doubt many criminals were the result of depraved conditions and characteristics which they might have inherited, but in the majority of cases, he believed, criminals were not the products of those conditions, but of the adverse social conditions in the midst of which so many were born and had to live. If they wished to diminish crime, the proper way of doing so was not by gaols and reformatories, but by doing all they could to ameliorate the social conditions of the most degraded of our population. Even that would not abolish crime, but it would go a long way to mitigate it. Mr. Tallack had pointed out time as an essential element in reformation. Lord Kimberley, in his Report on Prisons in 1879, went over all this ground most carefully, and at the end of the inquiry then conducted by him he came to the conclusion that in those prisons where most time had been given to reform the criminals the result was that the regimen to which they had been subjected not only failed to reform the offenders, but produced a deteriorating effect upon them. If you kept people too long in prison you not only did not reform them, but depraved them. He had seen that occur in hundreds and thousands of cases during his work in English prisons. He was delighted to see that the system in operation in the Andaman Islands was to a large extent different from that at home. There, there, was a really progressive system, not a sham as it was here. The convict was gradually accustomed to liberty and to depend upon himself; he was allowed privileges which would never be dreamed of in this country, and he felt sure as the result of what was going on that there was infinitely less recidivism. In this country habitual offenders were perpetually on the increase, but he understood that in the Andaman Islands there was hardly such a thing known. The reason was as plain as possible, because there was a proper system of progressive stages by which the prisoner was accustomed to liberty, and the result was when he was ultimately freed he felt so little the restraint of the prison that he remained in future a espectable member of society. He hoped this paper would be widely read, and would produce some i pression upon the home administration, so as to red the great number of habitual offenders which crowd our prisons.

Sir Owen Tudor Burne, G.C.I.E., K.C.S said that it gave him sincere pleasure to propos formal vote of thanks to Colonel Temple for a pa which was not only well put together but well re giving an example of terseness and good delive The noble Chairman had alluded in feeling ter to the tragic event which happened at Port Blair February 8, twenty-seven years ago. As one w had been closely associated with Lord Mayo, wl Viceroy, it might be of interest to those present if mentioned that on assuming office in India t lamented nobleman frequently spoke of his gr interest in the Andamans and his wish to v that settlement with a view to see what improveme if any, could be effected in the administration, w the special object of civilizing the convicts, shorten the term of their transportation, instructing them trades, and, in short, putting the settlement on basis so well carried out during past years or so, a so admirably and impartially described by Colo Temple. Lord Mayo also had a special wish to Mount Harriet, which he thought might be made i a sanatorium for Calcutta. But, alas, all the be ficent views held by the Viceroy were cut short, the moment, by the mournful event so accurat described by Lord Northbrook, an event wh deprived India of one of her noblest and b viceroys, notwithstanding the precautions agai danger taken, not only by the personal staff, but the Chief Commissioner of the settlement. In p posing a vote of thanks to Colonel Temple, he ho he might also be allowed to express the obligation all those present to the noble Chairman for so kin and so ably presiding over their proceedings.

A vote of thanks having been carried unanimou

Colonel Temple said he would only refer to t points which had been raised in the discussion, first, in reply to a query from the audience, he wo say that the climate of Port Blair was that of ordinary tropical island situate in about 10 to degrees north latitude; it was very hot and v wet, there being about 200 inches of rain, otherw it was not unhealthy. The temperature was har ever below 75 and hardly ever above 100, bu shower of rain would wet you through in l than two minutes. Firstly, then, about escap they were exceedingly difficult, and he should that perhaps not more than three or four per ce of the men who tried to get away ever lived to acco plish it. There were a certain number of men miss every year, but most of them were either drowned got lost in the jungle. Those who did get to foreign country were almost immediately poun upon by the police and sent back, and they had

wonderful stories to tell of what had happened iem on the way. He had known six or eight escape in an open boat in the middle of a soon, when the weather was so bad that the steamer was detained one day on a journey of y-six hours! But these men, without food or ing, managed to get across to Burma, where, moment they landed, they were taken by the e and sent back. The native Andamanese ys help to catch escaped convicts, because these having no food or means of support had to steal the natives, which, of course, excited their iosity. Secondly, there was hardly any recidivism of the 400 or 500 who were released every year; aps one or two per annum came back: but for there were two reasons, one was the system h he had described, and the other that the sed convicts were not young. Every man was for 20 years, and the majority of them about ears, so that they were somewhat advanced in when they were discharged, and in India a man of ears of age was quite old. Although they were emely anxious to get back home, he did not think lived very long afterwards, as the change of ate probably killed them off.

EVENTH ORDINARY MEETING.

Wednesday, February 22, 1899; Sir WESTBY PERCEVAL, K.C.M.G., Member of the ncil, in the chair.

he following candidates were proposed for tion as members of the Society :—

ve, A., 2, Albion-street, W.
, Arthur Frederick, 140, New Bond-street, W.
ison, Sir Samuel G., Nottingham.
ton, Arnold, 6, De Grey-road, Leeds.
aw, W. J., Woodfield, Streatham-hill, S.W.
itbread, S. Howard, M.A., J.P., Southill, iggleswade.
ite, Franklin, Hazlewood, Keynsham, and Johan-esburg.

he following candidates were balloted for l duly elected members of the Society :—

ans, Herbert William, 38, Chester-terrace, Regent's-park, N.W.
lin, William Henry, B.A., Irthlingborough Iron Works, Wellingborough.
npion, Alfred, Blochairn Steel Works, Glasgow.
icar, Alexander Louis, Hauteville, St. Germans-place, Blackheath, S.E.
fcken, Arthur W., Wyandotte, Shirley, South-mpton.
dalla, Florance Montefiore, 33, Addison-road, W.
igham, R. T., 6, Finsbury-square, E.C.
rris, Major Stephen L., R.E., 6, Wemyss-place, Edinburgh.

The paper read was—

THE GOLD MINES OF WEST AFRICA.

By JAMES IRVINE, F.R.G.S.

Unlike the Transvaal and Westralia of to-day, or of California and Australia of fifty years ago, the Gold Coast of Africa has a history, which it is necessary should be understood and remembered in order to appreciate fully its importance now; and, with your permission, I propose to give a brief sketch of that history, although I am aware that to many of you I shall not be able to unfold anything new.

The first records we have of gold in that part of the world take us back to the days of Herodotus, the "father of history," some 450 B.C., who tells us that the Carthaginians obtained their supplies of gold from black people who brought it across the great desert from the western shores of the continent; and he thus, in an untentionally amusing manner, describes the trade by sea which was then carried on:—

"There is a nation beyond the Pillars of Hercules which they are wont to visit, where they no sooner arrive but forthwith they break cargo, and having disposed their wares in an orderly way along the beach, leave them, and returning aboard their ships raise a great smoke. The natives when they see the smoke come down to the shore, and laying out to view as much gold as they think the worth of the wares, withdraw themselves afar. The Carthaginians upon this come ashore and look. If they think the gold sufficient, they take it and go their way, but if it does not seem enough, they go on board once more and wait patiently. Then the others draw near and add to their gold till the Carthaginians are content. Neither party deals unfairly with the other, for they themselves never touch the gold till it comes up to the worth of the goods, nor do the natives even carry off the goods till the gold is taken away."

And evidence of this early trade is also said to be supported by other writers upon this part of the world, though whether they describe it in the same glowing terms of simplicity and good-will I cannot say. It is very clear that those days are far removed from ours, with their "grabbing" of hinterlands and keen jealousies between race and race.

I shall not, however, detain you over those far-away histories and these modern moralities, but bring you down to a comparatively recent period, though even here we are forced to go back to the early 14th century, when the French were said to have recommenced the trade in gold with the natives then resident at

Elmina; just 100 years before the arrival of the Portuguese.

Whether the claims of the French are good or not, it is certain that the Portuguese under Baldeza brought gold in 1442, and that in 1470 other navigators brought supplies of it from the mouth of the Prah; also about this period another Portuguese merchant, Fernando Gomez, bought the monopoly of trading in gold dust for five years for the sum of £50 a year, and on giving an undertaking to explore annually a line of 350 miles of coast.

This exploration led to the opening of large and important mines, to defend which it is assumed that the Castle of Elmina was built, and a flourishing trade was carried on till early in the 17th century, when the mines were shut down and the digging of gold made fetish by the King, since which time no gold has been worked in that neighbourhood. This trade was continued in gold and slaves from other districts of the Gold Coast until Guinea became the great gold-producing area of the old world. This name of Guinea, which gave the designation to our 21s. piece on account of the mineral from which it was made coming from this district, is supposed to have arisen ages before from the natives of Jenna on the Niger, who traded in large numbers with the Gold Coast, and when asked by the Europeans from which place they came, replied Jenna, or Genna.

The first Englishman who brought away the precious metal was Captain Thomas Wyndham who, in 1551, brought to England 150 lbs. weight of gold dust, worth about £10,000. This result so encouraged the merchants of those days that they fitted up three vessels, the *Trinity* and the *John Evangelist*, each of 140 tons, and the *Bartholomew*, of 90 tons, and these three vessels returned with gold, ivory, and grains of Paradise, valued at £34,100, and some slaves.

Stories of sensational riches come down to us from those ages, and the barbaric splendour of some of its past rulers freely justify such traditions. Ghana was famous among the ancients for its golden throne, Bontuko for its golden stool, while Bowditch tells us that the King of Gaman, of which Bontuko was the capital, had steps of solid gold by which he ascended to his bed. The Ashantis were most proficient in the manufacture of ornaments made from gold, but were surpassed by the people of Dagwumba, who inhabited a large territory to the north-east of Ashanti, ornaments being made in weight to the extent of more than 1,000 ounces.

To conclude this part of my subject, the particulars of which I have freely used fr the pages of Bowditch, of Ellis, and of M Donald, I will quote from the late Sir Rich Burton in his book, "Wanderings in W Africa." Sir Richard says that about period, cupidity having mastered terror of Papal Bull which had assigned to Portu the exclusive right to this trade, Engl French, and Dutch adventurers hasten early in the 16th century, to share the sp when a flood of gold poured into the la Europe, and as much as £3,000,000 shipped from Elmina alone early in the 1 century. Sir Richard also says, and upon I shall have some remarks to make later that as we advance northwards from the C Coast the yield becomes richer, and tha Ashanti the red and loamy soil, scattered w gravel and grey granite, is everywhere impr-nated with gold.

I now come to the present day, and it is Sir Richard Burton we are indebted, more th to any other man, for drawing public attent once again to this ancient gold-field. In 1 was published the book I have already nam "Wanderings in West Africa," to be s-ceeded by his joint work with Comman Cameron, C.B., entitled, "To the Gold Co for Gold," and published in 1882. In both these books he expressed his amazement t the intelligence and enterprise of the pres day had not sent men and machinery, for b remembered all the wealth described had b obtained in the most primitive manner by s-face washings, or by pounding the quartz hand, which had been obtained from sha rarely exceeding 50 feet in depth—at wh depth the natives, having not the smallest id of pumps or modern machinery of any s were invariably drowned out.

In parenthesis I may say that all the m-chants trading to the entire West Coast Africa, notably Messrs. Swanzy and Co., w testified in a Blue-book fifteen years ago t their firm had received in exchange for Engl manufactures not less than £1,000,000 in g dust—were aware of this vast wealth, but steps, as I have said, had ever been tak scientifically to develop the mines until ab the years 1880 to 1882. At that period seve companies were started, most of them w totally insufficient capital, and the few wh had enough had neither experienced men guide them nor scientific knowledge of a kind on their Boards, and the result w natural and inevitable.

ere is this to be said, however, in defence e management at that period, that really vorthy experts and managers were few ar between. Gold mining had not become ience it is to-day, for all will admit that ledge in this respect has been obtained aps and bounds during the last ten to n years, and an enterprise which can now with the Banket formation of the Wassau with as much precision and with as great ity as with a well-defined coal formation in umberland, had not then been thought of. also to be remembered that East Indian mining, and the early days of the Trans- were calling for all the experienced gers, and that West Africa with its evil came in as a bad third, only getting men as a rule, could not find employment else-e; nevertheless those pioneer days, full isfortune to many shareholders, and dis-t, often very undeserved to others, had use, and the workers of the present are ing into their labours and reaping the . In this manner. Not one single com- which afterwards came to grief did so use they found no gold—absolutely every-found gold, ranging from so many dwts. e surface to 9 ozs. at greater depth, and dwts. cover all working expenses, it d beyond question that with capital to op, every mine would pay dividends in Unfortunately, however, in each in-e the capital, often, as I have already too small, had become exhausted at a when the entire commercial world was in ckwater of depression, caused partly by losses (less in Africa, however, than in), but still more by the political unrest h has weighed so very heavily on all mate enterprise during the last 10 or 15 s.

t all African gold companies did not then some held their ground through good agement, and the use of money advanced ose who had the power and who believed great future. The result is that we have company which gave an average yield last of 28 dwts., with crushings of about 6,000 of conglomerate, and which has an esti-d amount of gold of £5,000,000 sterling, l intents and purposes proved.

a meeting of the Geological Society of lon, held on the 20th April last, a paper read on the origin of the Wassau con-erates, and in the discussion which fol-d, an experienced authority on the subject he did not agree with the reader of the paper in thinking that the West African conglomerates were derived from the dis-integration of the existing range of mountains which were found a little further inland, but he thought they undoubtedly belonged to a far earlier period, and were similar in age to those in South Africa. They were evidently part of the series of sedimentary deposits which so largely predominates over the surface of the African continent. He thought that in these conglomerate beds of West Africa there would be found to be deposits as extensive and as rich in gold as those of South Africa.

Regarding this property just referred to, one of the directors, whose experience and whose character gives weight to his opinion, said, publicly, in July last :—" I am looking to the time when, like the Crown Reef, we shall be paying 200 per cent. ; their stuff is very much poorer than ours."

Another company which, under continuous crushings since June of last year, has given an average of over 1½ ounces to the ton, but, so far as I know, the directors of which have not ventured on an estimate of their gold in sight ; another which has held up its head since 1880 has obtained an average of fully 1 ounce to the ton, with many thousands of tons crushed ; another, the gold of which was so pure that 84s. per ounce was offered, or if the quartz could be shipped home uncrushed, the smelters at Swansea agreed to buy it at £20 6s. per ton on the standards of samples assayed.

It may not be out of place to recall Sir John Glover's statement, made in the Town-hall of Liverpool on his return from the Ashanti War of 1874, that on that splendid march of his from the Volta to Kumassi he passed through districts where you could dig up gold as you would dig up potatoes. Some of us heard that statement, and Sir John was not given to exaggeration, though, of course, in this there was allowably some hyperbole. I can make many other similar statements regarding the value of the West African reefs, for which I hold documentary proof, but these will suffice.

I am not here to advertise any single mine, but I am pleased to have the opportunity of drawing attention to the phenomenal richness of the mining districts on the Gold Coast of Africa, and to state as my well-founded conviction, that we are on the eve of a success which has probably no parallel in the history of any era or of any colony.

I said in a previous part of my address that I would refer to Ashanti. This kingdom, as you all know, has only recently come under the

Government of Great Britain, and sufficient time has not been afforded for the same amount of development, but what development has taken place has been absolutely surprising. About two years ago a concession was obtained which left no doubt about the richness, and as the capital—in this case not too small—was easily obtained, steps were at once taken to send out and erect machinery, with the result that a reef 25 feet wide was attacked, not by expensive shafts, but as a quarry, and crushings of many hundreds of tons have yielded an average of three ounces to the ton; indeed a well-authenticated rumour has it that at this very moment they are crushing quartz which is giving eight ounces to the ton.

Another property which adjoins it was inspected and reported upon by an expert of high standing, but his story was considered so improbable that a second mining engineer, of experience and probity, was sent out at great expense, and he not only confirmed the previous report, but placed an actual estimate upon the property, valuing the amount of gold easily recoverable at £6,000,000 sterling.

Mr. MacDonald, from whom I have already quoted, estimates, at page 112 in his book, that gold to the value of not less than £600,000,000 to £700,000,000 had from time to time come out of the Gold Coast.

I feel sure I must in this hasty review have said enough to prove the enormous richness in gold, and that the name of the Gold Coast is a correct description of the territory.

I shall now proceed to speak of the titles under which these concessions are held. The properties are, in the first instance, obtained from the chiefs who have, by native consent and approval, owned them for generations—by purchase, or by the payment of an annual rental, or by royalty on the gold won. A regular deed, with all the formality and tautology of a similar document in England is drawn up and signed in the presence of the English District Commissioner, who explains, through an interpreter, the meaning of it, and who then affixes his seal to a statement that the vendor clearly understands its import; the deed is then taken to the duly appointed English official and registered. In the main this has answered very well in the past, though difficulties not infrequently arise afterwards, when other natives come forward to say that the first vendors did not own this property—but I have never known a case where the English purchaser had to give it up, as with tact and reasonableness every native ca be dealt with.

These cases and other points, such as he possible overlapping of properties, have, l v-ever, led the Government to see the nece ty of guiding and controlling such native gr s, and a Lands Ordinance Act has therefore l n under arrangement for some time; and at one will be passed after due consideration, ut not until due consideration has been give o it, not by Government officials only, is he desire of everyone.

In this connection I may state that consi -able anxiety was caused by the prop d Lands Bill of the late Governor, which, h -ever, fortunately was rejected by Mr. Ch -berlain, who assured a deputation of na e traders sent over to this country to repre t native interests, that the future Bill woulc e framed on just and equitable lines, and ackn -ledging the laws dating from time immemc il of the native kings, chiefs, and families; a ll report of this interview is to be found in a la e pamphlet published on the 5th August last, y Messrs. Ashurst, Morriss, Crisp and Co., e solicitors representing the deputation, an I am pleased to be enabled to quote fron a letter which I received a few days ago fi n Cape Coast Castle, as follows: —

"To-day there was a mass meeting in the Cha -square to receive the message from the represe -tives of the aborigines who went to England c the Lands Bill. By what I can understand, eve thing is settled amicably for them, and the ki retain their right to sell or dispose of their lands they think fit; the Government recognising native customary laws."

Let me now speak of that all-import question of climate, which has so far been t greatest, perhaps the only real difficulty, a that it is a difficulty of grave and sad impo -ance no one will deny.

The experience of everyone during the l 10 or 15 years has unfortunately been that t engineer-in-chief after six or twelve months his mine, if he has not died, has sickened a fled, and another, after perhaps weeks months of anxiety on the part of boards England, has been found, sent out, and many instances with the same result, un despair has well nigh broken the heart of eve director; but that all this has come from t climate itself is far from the truth—muc perhaps one half, of the illness has been caus by the men themselves. I had the misfortu to know one case in point where the direct of a company waited for six months to g

particularly experienced man whom they ght home from Venezuela, but whose acter had undergone sad deterioration : the chairman had last seen him. This drank 34 bottles of brandy, champagne, beer on his journey of 24 days, landed k, lived drunk, and in 21 days died drunk, the climate got the blame. This is an me case, but cases half as bad, or even fourth as bad are common and bad enough, it is this more than the climate itself which s the character to West Africa.

lo not hesitate to say, and there are gentle- in this room who by practical experience ars can bear me out, that given sobriety, non sense, and plenty of work to do, with best food and the best quarters which ey can procure, the climate of West a is not one whit worse than many other r tropical possessions. The experience of important company is worth giving here pport of my last remark. This company been working successfully, and during the ten years has only had four deaths tly due to the climate and two others ectly due to the same cause.

ien I ought also to point out that the ality and sickness, especially of late years, I think, been largely among Government als; it is, therefore, much more in nce. This is to be traced to two mes of life: one which calls for our ect, admiration, and sympathy in the of those grand fellows, most of them g, who are the makers of our empire, and are forced to bear hardships of exposure, egular and of insufficient food, and who, out a murmur, endure, do their life-work— die. The other extreme is thus referred y Mr. MacDonald, in that capital book is, from which I have already quoted:—

So the Gold Coast has gone on from year to with its death-rate much about the same . . . work in the same department, limited pation, scanty amusements, poor and insanitary ers, have all contributed to keep up the bad of the colony, and to embarrass commercial ress in one of the richest of our tropical ssions."

it these conditions are not going to con- . They are not a necessity of West a, and they are already disappearing; dy we are finding a very different class of neers and miners, partly because we have, g to the increase of the mining industries e world, which afford schools of education, uch larger and a more respectable field from which to choose our managers and men, and partly because of the attention drawn to the question of health.

In this connection it is fitting that I should refer here to the magnificent offer of the President of the African Section of the Liverpool Chamber of Commerce, Mr. A. L. Jones, who has undertaken to give an annual grant of £400 to cover, in Liverpool, the cost of research into the origin of malarial fevers, and it is perfectly reasonable that we should look for such an improvement in the sanitary condition of West Africa as we have had, say, in Calcutta, under which our young men of the next generation will prefer Africa to India.

What do we find was the condition of Calcutta when that city of palaces and of wealth was founded. Sir William Hunter says in his delightful book, "The Thackerays in India:" "Our ancestors found Calcutta a swamp, and they created on it a capital;" and this is the description of it. After stating that one or two families of Sets and Baisaks, just as one would say one or two families of Bonny men, Calabarese or Fantees, settled at the Cotton Mart overlooking the river, he adds:—"That bank sloped down into a swampy jungle which at places came right down to the river's edge, at others there was a strip of fairly raised ground between the river and the swamp, and behind it spread the vast agglomeration of brackish lagoons, a pestilent region, long given up to the tiger and the crocodile." "By creeks through the narrow strip of high ground along the river bank the fetid ooze from these fens swayed backwards and forwards with the rise and fall of the tide." This description, which those of you who know West Africa would consider an exaggerated one for even the worst part of it, is what Calcutta was at its foundation, and which, as late as 1757, gave the result mentioned in a letter from the Admiral's surgeon, when he reported "that of the 250 soldiers who came with Kilpatrick in August of the previous year only five survived their commander."

Another authority—Rennell—speaks of it as a climate which proved so prejudicial to European constitutions that scarcely one out of seventy men returned to his native country.

This is what Calcutta was only a few generations ago, infinitely worse than anything we have ever had in West Africa, except, perhaps, in the epidemic which visited "the rivers" in 1860, or thereabouts, and we are entitled, therefore, to hold the conviction that, with the superior knowledge and appliances of

the present day, we shall have a state of things and at no distant date, which will raise the health of West Africa to a level of that rejoiced in by the thousands of our countrymen in India.

I must now bring this paper to a close, but I cannot do so without acknowledging our indebtedness to Mr. Chamberlain for the extreme interest he has taken in the development of ths part of our colonial empire. It is true that he is only carrying out the resolution come to by Lord Ripon, his predecessor in the last Liberal Government, who pledged himself to the extension of railways and other developments; but none the less, or perhaps all the more, do we feel our indebtedness to him, and it is fitting we should state that he has not only met every deputation and every request with the accustomed courtesy of the Colonial-office, but what is not so usual, he has fulfilled his promises, and has given a fostering hand to every scheme which has had for its end the welfare and the advancement of this part of Her Majesty's dominions.

It is with pleasure I quote from his speech at Manchester on the 16th of November last, on which occasion he is reported to have said:—

"We had secured a sufficient hinterland for our colonies on the Gold Coast and at Lagos, and he ventured, standing here, to predict that before five years were over those colonies would be amongst the most valuable possessions of the Empire."

I now very briefly refer to the railway so happily begun from Secondee to proceed to the Wassau Reef, and thereafter to Kumassi along a gold belt unequalled in its richness in the whole world. That this line will pay from its opening day there cannot be an atom of doubt, for there are a dozen mines—I might well say dozens of mines—waiting to begin operations until they can get up their machinery and material at profitable rates. At present the cost of transport ranges from £18 to £50 per ton according to weight of packages, but that is the least part of it; the impossibility of getting up heavy enough machinery forms the most serious obstacle to the success of the mines, and this will disappear with the opening of the line; it will then also be possible to carry up a large traffic in coal for driving the machinery (a necessity becoming rapidly very urgent owing to the growing scarcity and expense of wood), or perhaps, and still better, crude petroleum for the same purpose, of which there is every reason to believe an unlimited supply exists only fifty miles to the westw[ard] and on the sea coast.

I shall not detain you longer. We have s[een] during the 15 years an extraordinary race [on] the part of English, French, and Germans [for] possessions on the continent of Africa—[and] though we might have had a larger shar[e]—indeed, but for the folly of our Governme[nts], Liberal and Conservative alike, 20 years a[go], we might have had the whole of it—I [say] though we might have had a larger share, [we] have by no means come off badly, as, with[out] question, the richest portion has fallen to [us]; that obtained by the French, though m[uch] larger in area, is, as Lord Salisbury humorou[sly] said some years ago, what our farmers would [call] "light soil," and as for the German porti[on], it is probably valuable, and will be fairly w[ell] developed, nevertheless, I make the statem[ent] that neither French nor Germans knew w[hat] they were after when this race began, and [I] venture further to prophesy that in another [few] years they will be heartily sick of it, a[nd] anxious to hand all over to us. It has alrea[dy] been made apparent that they had not coun[ted] the cost, and that they cannot successfu[lly] deal with the native races as England ca[n]. She has proved her powers, her fairness, ki[nd]ness, commonsense, all over the world, a[nd] not least, in recent years, in Africa, and to-d[ay] we have on her coast, and in her far interi[or] men of refinement, as well as others who a[re] blocks of rough-hewn British manhood, so[me] of them, perhaps, not beautiful personag[es], for the founders of England's greatness ha[ve] not usually been those who wear soft raim[ent] and dwell in king's houses, but men who ha[ve] a work to do, and do it with no thought of s[elf], and with a resolute courage which no dang[er] can daunt and no difficulties turn aside.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said [he] hoped they would hear something from those w[ho] had had experience on the Gold Coast, with reg[ard] to the three important questions of the supply [of] labour, water, and fuel, because unless those con[di]tions were satisfied, there would be great difficulty [in] getting the gold, however abundant it might be.

Mr. F. SWANZY said he had no personal experie[nce] of the Coast, though his name had been connec[ted] with it for a century, and he himself had had a gr[eat] deal to do with gold-mining there. With regard [to] labour, the Governor of the Gold Coast told him o[nly] a few nights ago that the supply was very large, a

had been proved by experience in the construc- of the railways. Something like 10,000 men employed in the construction of the three rail- , and though at the time of the first survey it was ested that Coolies or Chinamen might have to be duced, nothing of the sort was found necessary, two of the railways had been constructed entirely native labour. A large mahogany industry had y been started, and there had been no lack bour for squaring and shipping the logs. They been working at mines there for some years, and that they would have the *pax Britannica* over a portion of the hinterland, the tribes, instead of ing one another, when they found there was work e had, would be glad to get it. Miss Kingsley written to him to say that she could get him a large supply in a short space of time, if needey. n evidence of the traffic in gold in past times, he ld refer to the presence in the country of aggrey ls, which were referred to by Ellis. They were a ous sort of mosaic, which were now imitated by etian manufacturers, and they were found chiefly e western part of the Gold Coast; and were pre- y similar to beads found in the mummy cases gypt. The theory was that the Venetians in times came to the Gold Coast, and exchanged beads for gold. The natives dug them in the ground, and the current saying was they were worth their weight in gold, which was suggestive as to their origin. One writer re- d to an ancient lamp having been found in ng operations, and to other traees of mining ng taken place centuries ago. Coming to later s, there was an interesting book called "The len Coast," published in 1616, which bore the pertinent Latin motto, "Quis nisi mentis inops tum repuit aurum?" which he should translate, ho but a fool will refuse gold when it is offered ?" In the preface the author referred to the derful amount of gold to be obtained there, and that when he remembered what was related of es past and of the present, he was reminded of assage in Sallust, in which he referred to men g incited to worthy deeds by the sight of images portraiture of their ancestors, his idea evidently g to urge the men of his own day to go to the d Coast and make their fortunes. Another author, ing in 1799, said the natives believed that rain cended from God, rendering the earth fruitful, and trees productive, and washing down the gold n the mountains. Also that in the beginning God e the black men the choice of having either gold a knowledge of the arts and sciences, and the ks, having chosen gold, He condemned them, for r cupidity, to be slaves of the whites. It was rated in Beauchamp's "Ashanti and the Gold st," that his (Mr. Swanzy's) grandfather gave lence, in 1816, before a Commission, when Government thought of taking over the d Coast from the African Company, and ed that at that time it was supposed that the Gold Coast produced 10,000 ounces annually; that the soil of Ashanti yielded a large amount, and that on one stream alone 8,000 or 10,000 slaves were employed in washing for two months in the year. There were also mines, the gold from which was called "rock gold," but many of the richest mines were dedicated to the national deities and were protected by popular superstition. The reference to the emulation amongst European nations in Africa reminded him of the similar competition in past times which was referred to by Mr. Bosman; he enumerated the Dutch West Indian Company, the English African Company, the Zealand and English interlopers, the Portuguese, and the French.

Mr. T. J. Alldridge said he knew nothing about the Gold Coast, and could only speak of the climate on that part of the West Coast with which he had been connected for twenty-eight years, viz., Sierra Leone, and which was as bad now as when he first went there. But if you left the mangrove swamps and went into the interior, the climate was entirely different, and you could live there almost as well as in England. The great thing was temperance, and there was no doubt many men took more liquor than was good for them; at the same time every excuse should be made for men who were compelled to reside in isolated places, seeing nobody, and one or two hundred miles from any kind of civilisation. He had only just re- turned from West Africa, having had to pass through the massacre at Sherbro and other parts of the protectorate of Sierra Leone, and he must say he was very glad to get home with a whole skin, for at one time things looked very black. He never experienced so much pleasure as when a British ship came into the harbour and landed a force of bluejackets and marines, which in all probability saved their lives.

Miss Mary Kingsley said she had nothing to add to what Mr. Irvine had said about the gold mines, except to say that the accounts given of the enormous quantity of gold in that region was fully supported by all the literature regarding it, with which she was acquainted. The great Company of Royal Merchant Adventurers of England, of the time of Charles II., used to coin from 30,000 to 50,000 guineas a year from gold obtained there, and though those coins were originally intended to be worth 20s., their intrinsic value never fell below 21s.: they were, she understood, always stamped with the elephant, which was the seal of the company. With regard to the labour question, she agreed with Mr. Swanzy that there need be no difficulty if they treated the people properly, and did not spoil the market by com- mencing paying too high a price for absolutely un- trained labour.

Mr. W. H. Swift said he had been on the Gold Coast from 1883 to 1896, and had worked on the reefs and alluvial deposits in the neighbourhood of Tarkwa and the Ancobra river. The bankèt reef was one of the finest reefs in the world. One quartz reef had

been traced for 20 miles, and to his own knowledge averaged 7 or 8 feet in width; it was a true fissure vein. He did not think Mr. Irvine had made quite enough of the transport difficulty which, in his experience, had been the chief cause of the failure of West African mining. Secondly came inefficiency of capital, and thirdly the companies in London made a great mistake in rushing for returns before the mines had been developed; they sent out stamps and expected returns before any real mining work had been done on the property. The transport difficulty, however, was the chief obstacle. He knew one company which had lost from £10,000 to £15,000 on the bar in the Ancobra river in specie and machinery. The railway would be the saving of the country. When the railway got to Taquah that would be the centre of a large and rich gold-mining camp, and eventually it would reach Ashanti, where there were enormously rich reefs. There were parallel reefs right across the country from the sea, and his firm belief was that it was the richest country in the world. There was plenty of water for all mining purposes, and, up to now, plenty of fuel. He found no difficulty with regard to labour. He had had experience of Chinamen, Dyaks, and others, and he found the men of the West Coast quite equal to them. They were superior to those in South Africa, as they made good artisans, engine-drivers, carpenters, and fitters.

Mr. B. A. COLLINS said he could endorse what Mr. Swift had said; but one of the principal questions had not been touched—that of roads. There were lots of roads marked on the good charts which did not exist at all; you had to cut your way as you went along. The chiefs of each village, however, were perfectly willing to cut the roads provided they had a little encouragement from the Governor, and that was the only complaint he had against the present adminstration. He was taken ill at Dunkwa and was told that he could meet Captain Donald Stewart and Dr. Henderson who were going with him to Kumassie if he could push ahead. He sent word ahead that there was a white man ill who wanted to get on, and the natives came out and cleared the road for him for forty-five miles; but he found afterwards that this was done because they thought he was a Government official.

Mr. F. P. T. STRUBEN, who said he claimed to be the discoverer of the Johannesburg gold-fields, having had a battery running there before anyone else came, said the conglomerates of the West Coast were absolutely identical geologically with the Johannesburg bankèt; and not only so, but they had been proved to extend over a very large extent of country. The reefs, as they were called, were nothing more than beds of a sedimentary deposit, and those on the West Coast were equal in size to anything in Johannesburg. They had been proved to 300 ft. in depth and 18 in. to 7 ft. in thickness. Their richness had also been proved to be equal to those in Jo[...]nesburg. Mines had been running over two y[...]s, from which an oz. and upwards had been obta[...]d, running over the plates or in the first process, w[...]ch was a greater yield than was obtained in the T[...]s-vaal. He did not mean to say that the conglome[...]es on the West Coast on the whole were richer [...]an those in Johannesburg; but if they were onl[...]as good, they were good enough. In Johannes[...]g they produced something like £16,000,000 w[...]h annually, and very likely this year the yield w[...]d reach £20,000,000, and at least an equal qua[...]y might be obtained from the West Coast. T[...]e was also the advantage that the mines [...]e within about forty miles of a port, and [...]e distance from Europe was not much more than [...]f, so that great economy would be effected in that [...]. With regard to fuel, it was the general rule tha[...]e conglomerates went with the carboniferous se[...]s, and, from a geological point of view, coal mus[...]e found in the neighbourhood. His own opinion [...]s that coal measures would be found in a north-[...]t direction from the gold mines. But even if [...]y were not, coal could be sent from Europe at a rea[...]-able rate, and the gold in that region being pu[...], fetched £4 an ounce against £3 15s. at Johan[...]-burg, the difference would meet any extra [...]-penditure for fuel, if it were necessary. It had [...]n demonstrated in Johannesburg that conglome[...]e beds, if once found of a payable nature, could[...]e worked as a regular industry, not as a speculat[...]. The depth was, practically, unlimited, becaus[...]a formation which extended for 25 or 30 miles [...]n the surface must be of great depth; it could not [...] mere streak.

Mr. LOUIS GOWANS said he could corrobo[...] what Mr. Struben had said as to the conglomer[...]s on the West Coast being identical with those [...] Johannesburg, but he would say that there we[...]t present no gold mines on the Gold Coast, in [...]e sense in which the word was used in the Transv[...], and would not be until they were made. [...] mining on bankèt could be made a regular indus[...], but it required patience. It took time to mak[...] mine, sometimes from two to five years before [...] substantial returns could be expected. Therefo[...] required faith. You might always have faith [...] bankèt, but not always in quartz. Money inve[...] in bankèt was as safe as in a bank. As to [...] climatic and other difficulties, they could all be o[...] come by engineers with plenty of money at t[...] back; but you must put money into the cou[...] before you could expect dividends.

Dr. D. MARTINI asked what was the weigh[...] stamps and other machinery necessary to properly t[...] these conglomerates. He had heard of s[...] machinery being sent to a mine 85 miles inla[...] which had to be abandoned half-way, and left to r[...]

STRUBEN said he should not advocate any achinery being sent out; it would be simply a of time and money. To work conglomerates d stamps weighing from 9 cwt. to 12 cwt, and the want of such stamps which had been able for a good many failures. For such heavy iery, of course, good means of transport were al. If it was made to take apart in small pieces nvenience of transport it never worked satisfy when put together. The boilers, of course, d to be of large size to work the stamps, as ne required from 1 to 1½ horse-power.

CHAIRMAN, in proposing a vote of thanks to vine, said no reasonable man could doubt after had been said, that there was gold in large ties on the West Coast of Africa. Hitherto, eat difficulty had been that of transport; but knew that the railway was just approaching tion. He had often discussed it with Sir gu Ommanney, and no doubt it was a work had cost the country both money and lives, but ifficulty would soon be at an end, and it looked here would then be a good field for the investof capital there.

vote of thanks having been carried unaniy,

IRVINE, in reply, said there was not the loubt there was coal there. Some 20 years e had all the details given him of the dis- of coal in the direction Mr. Struben d to, north-west of the gold district, s yet nothing had been done to work it. uestion as to the cost of transport had been d to by several speakers, and no doubt it was at importance, second only to that of health; he difficulty was rapidly disappearing, and by d of the year he hoped they would be able to achinery up to the mines on the Wassau of hills; and from there he believed the line l go on to Kumassi as fast as it could be coned. There it would open up a very large and istrict, and would also be of great importance ally in securing order in the whole country.

Notes on Books.

OR FRENCH COURSE. By Alphonse Mariette. London and Paris: Hachette.

e first part of this manual consists of a number es and remarks bearing on the difference of conion between the English and French languages, ged under the various parts of speech. Though ded for beginners, it will perhaps be more useful to those who have made considerable progress in the language, and are capable of appreciating such shades of meaning as the difference between *j'en doutais* (I doubted it) and *je m'en doutais* (I suspected as much) who would not consider that "a volatile Frenchman" would be idiomatically rendered by *un français volatile*, who do not consider that *un coin* is equivalent to *une pièce de monnaie*, or that *faire une tour* would be the proper translation of "to take a stroll."

The second part contains graduated exercises for translation from English into French, which afford ample opportunity to the pupil for the use of the information provided in the first part.

TELEGRAPHY. By W. H. Preece, C.B., F.R.S., and Sir J. Sivewright, K.C.M.G. Fifteenth Edition. London: Longmans. 1899.

This well-known work—first issued in 1879—has now reached a fifteenth edition. For the ninth edition the shape of the book was recast, and it is now said to have been freshly revised and to have received considerable additions.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 1.—"Leadless Glazes." By WILTON P. RIX. Professor J. M. THOMSON, LL.D., F.R.S., will preside.

MARCH 8.—"Cornish Mines and Miners." By J. H. COLLINS, F.G.S.

MARCH 15.—"Liquid Fuel." By Sir MARCUS SAMUEL. Sir EDWYN S. DAWES, K.C.M.G., will preside.

MARCH 22.—"London's Water Supply." By WALTER HUNTER, M.Inst.C.E.

Dates to be hereafter announced:—

"Preservation of Timber." By S. B. BOULTON.

"Coal Supplies." By T. FORSTER BROWN.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 9.—"Leprosy in India." By H. A. ACWORTH, C.I.E., late Government Municipal Commissioner for the City of Bombay.

This meeting will be held at the Imperial Institute.

MAY 11.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

MAY 25.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

FEBRUARY 28.—"Persian Trade Routes." By A. HOTZ. Major-General Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., will preside.

MARCH 21.—"The Commercial Development of Germany." By C. ROZENRAAD, F.S.S., and Fellow of the Institute of Bankers.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MARCH 14.—The paper announced to be read by Sir WILLIAM BLAKE RICHMOND is unavoidably postponed.

APRIL 18.—"Modern Changes in Taste relating to Domestic Furniture." By GEORGE LOCK.

MAY 2.—"Maiolica." By WILLIAM BURTON.

MAY 30.—"Wrought Iron Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

LECTURE II.—FEBRUARY 27.

Ball-bearings — Hubs — Pedals — Crank-brackets — Steering-head — Adjustment — Wheels — Direct-spokes—Tangent-spokes—Rims—Materials used in cycle construction—Steel—Malleable-iron castings—Wood.

LECTURE III.—MARCH 6.

Driving gears—Length of crank—Block chain—Roller chain—Chain-wheels—Bevel gear—Lloyds' cross-roller gear—Compound gears—Two-speed gears—Free-pedals—Tricycle-axle.

LECTURE IV.—MARCH 13.

Steel, rubber, and pneumatic tyres—Detachable tyres—single-tube tyres—Tubeless tyres—Valves—Inflators—Side-slip—Brakes—Saddles.

PROF. HENRY R. PROCTER, "Leather Manufacture." Four Lectures.

April 10, 17, 24, May 1.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Archibald Sharp, "Cycle Construction and Design."
Sanitary Institute, Margaret-street, W., 8 p.m. Lecture on "Laws relating to Food Supply."
Institute of Public Health, 20, Hanover-square, W., 8½ p.m. Professor J. McFadyean, "Tuberculosis in Cattle."
Imperial Institute, South Kensington, 8½ p.m. Mr. E. P. Rathbone, "The Right and Wrong Routes to the Klondyke Gold-fields."
Geographical, University of London, Burli[ngton] gardens, W., 8½ p.m.
Actuaries, Staples-inn Hall, Holborn, 7 p.m.
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., [5 p.m.] Professor W. Ramsay, "Recently Disc[overed] Gases of the Atmosphere."

TUESDAY, FEB. 28...SOCIETY OF ARTS, John-[street,] Adelphi, W.C., 4½ p.m. (Foreign and C[olonial] Section.) Mr. A. Hotz, "Persian Trade Ro[utes.]"
Royal Institution, Albemarle-street, W., 3 [p.m.] Prof. E. Ray Lancaster, "The Morphology [of the] Mollusca." (Lecture VII.)
Medical and Chirurgical, 20, Hanover-s[quare,] 8½ p.m.
Civil Engineers, 25, Great George-street, S.[W., 8] p.m. Messrs. W. T. Douglas and J. A. [...] "Improvements in Dioptric Apparatus for [Light]houses."
Photographic, 12, Hanover-square, W., 8 p.m. [...] Birt Acres' "Apparatus for Animated [Photo]graphy."

WEDNESDAY, FEB. 29...SOCIETY OF ARTS, John-[street,] Adelphi, W.C., 8 p.m. Mr. Wilton P[...] "Leadless Glazes."
Sanitary Institute, 74A, Margaret-street, W., [...] Prof. A. Bostock Hill, "Trade Nuisances."
Archæological Association, 32, Sackville-stree[t, W.,] 8 p.m.
Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MARCH 2...Royal, Burlington-house, W., 4[½ p.m.]
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m.
Chemical, Burlington-house, W., 8 p.m. 1. M[...] H. J. H. Fenton and Mildred Gostling, "[...] methylfurfuraldehyde." 2. Dr. Augustus E[...] Dixon, "The Action of Metallic Thiocyana[tes on] certain substituted Carbamic and Oxamic [Chlor]ides: and a new method for the product[ion of] Thiobiurets." 3. Mr. W. Trevor Law[...] "Ethylic ββ dimethylpropanetetracarbox[ylate]." 4. Professors Wyndham R. Dunstan and [...] Goulding, (*a*) "The Reaction of Alkyl Iodide[s with] Hydroxylamine." (*b*) "Formation of Alk[yl] Hydroxylamines and Oxamines."
London Institution, Finsbury-circus, E.C., [...] Rev. Canon Benham, "St. Alban's Abbey."
Society for the Encouragement of Fine Arts, [...] Conversazione at the Galleries of the [Roy]al Institute of Water Colours, Piccadilly, W.
Royal Institution, Albemarle-street, W., 3 [p.m.] Dr. A. Macfadyen, "Toxins and Anti-To[xins.]" (Lecture IV.)
Electrical Engineers, 25, Great George-street, [S.W.,] 8 p.m. Mr. B. Marconi, "Wireless Telegr[aphy.]"

FRIDAY, MARCH 3...Royal Institution, Abemarle-stre[et, W.,] 8 p.m. Weekly Meeting. 9 p.m. Sir Fre[deri]ck Pollock, "King Alfred."
Geologists' Association, University College, [W.C.,] 8 p.m. Mr. George Abbott, "Honeycom[b and] other Forms of Surface Weathering of San[dstone] and Limestone."
Junior Engineering, Westminster Palace [Hotel,] S.W., 8 p.m. Mr. W. R. Cooper, "[...] Consuming Batteries, and their Possibilities."
Quekett Microscopical Club, 20, Hanover-s[quare,] W.C., 8 p.m.

SATURDAY, MARCH 4...Education Department, South [Ken]sington Museum, S.W., 3½ p.m. Mr. W[illiam] Burton, "Pottery."
Royal Institution, Albemarle-street, W., Lor[d Ray]leigh, "The Mechanical Properties of B[odi]es." (Lecture IV.)

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FRIDAY, MARCH 3, 1899.

ommunications for the Society should be addressed to e Secretary, John-street, Adelphi, London, W.C.

Notices.

MUNICIPAL TRADING.

he following Memorial has been addressed he Council of the Society of Arts to the ne Secretary :—

Society for the Encouragement of Arts,
Manufactures, and Commerce,
John-street, Adelphi, London, W.C.,
February 23rd, 1899.

the Right Honourable Sir Matthew White Ridley, Bart., M.P., *One of Her Majesty's Principal Secretaries of State.*

IR,—The Society for the Encouragement of Arts, nufactures, and Commerce have been giving very ful consideration to the increasing tendency of icipal and local authorities to embark in trading rprises which may be in competition with, or to exclusion of, private enterprise, and they have had ibly impressed upon them the fact that as yet no tations have been defined as to what enterprises ld in the general interests of the nation be under- n by municipalities and local authorities, and t ought to be left to private effort.

hey therefore venture to approach you in the hope you may see fit to advise Her Majesty to appoint oyal Commission to consider the whole subject, to lay down the principles and limitations on ch Parliamentary powers should be granted to icipal and local authorities. They further venture submit that until such Royal Commission has stigated the subject and reported thereon, no her powers for trading purposes ought to be ted to such bodies.

We have the honour to be, Sir,
Your obedient servants,
(Signed) J. Wolfe Barry,
Chairman of the Council.
(Signed) Henry Trueman Wood,
Secretary to the Society.

CANTOR LECTURES.

Mr. Archibald Sharp, A.M.Inst.C.E., delivered the second lecture of his course on "Cycle Construction and Design," on Monday evening, 27th February.

The lectures will be published in the *Journal* during the summer recess.

FOREIGN & COLONIAL SECTION.

Tuesday afternoon, February 28th, 1899; Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., in the chair. The paper read was "Persian Trade Routes," by A. Hotz.

The paper and report of the discussion will be printed in the next number of the *Journal.*

ACETYLENE REPORT.

The Report of the Committee on the Exhibition of Acetylene Generators at the Imperial Institute has been published as a pamphlet, with appendixes, giving particulars of the tests, diagrams of the apparatus, &c. The price is one shilling; it can be obtained from the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

Any member desiring a copy of the pamphlet can obtain one gratis on application to the Secretary.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday evening, February 21, 1899; Sir Owen Roberts, D.C.L., F.S.A., in the chair.

The paper read was—

VITREOUS ENAMELS.

By Cyril Davenport.

I.—Early Enamels.

I do not intend this evening to trouble you much about the technical part of the art of vitreous enamelling on metal, but rather to mention a few elementary points only in order that you may more clearly understand the one or two simple terms I shall use in describing the finished examples, slides of which I have to show you on the screen.

Enamelling is, of course, the outcome of the very ancient art of glass-making, and it is likely enough that the discovery that certain kinds of glass will, under particular conditions, adhere to metal, was accidental.

I define an enamel, for my present purpose, as a glass film fused upon, and adherent to, a metal groundwork.

Glass, as we know it, is not one substance alone. (Silica 5, crystal borax 3½, and nitre 3½ makes glass easily with a blowpipe.) The main ingredient in all glass is silica, or, as we popularly know it, flint, and with this are mixed various other substances, which render it easier to fuse, and softer when fused.

A Japanese receipt for an enamel glass is given by Mr. Bowes as follows :—

	Per cent.
Oxide of lead	37·15
Lime	4·92
Magnesia	0·90
Soda	5·19
Silica	51·84
	100·00

This is colourless, but for the purposes of enamel workers such glass would rarely be needed; colour becomes a necessity, and it is easily produced by melting the proper kind of glass with the oxides of various metals. There are now many shades of enamel colours procurable, but in olden days they were few and simple—such as

Red, probably due to oxide of lead with mercury (Watson), or might be oxide of iron (Bowes).

Blue, oxide of cobalt.

Green, oxide of copper.

Different proportions of iron will give grey, yellow, and pink, and black may be iron or copper or manganese. The oxide of tin makes an opaque white, and the oxide of gold, on gold, a rich ruby red. When used with the oxide of tin any of these colours will make opaque enamels—without the tin they are generally translucent in different degrees. On impure metal translucent enamels are always likely to become opaque after the firing.

The most usual metals on which enamels are fused are gold, silver, and copper. Translucent colours will sometimes fuse satisfactorily on all these, but they are only to be relied on when they are on a fine gold ground. The process, roughly speaking, is to grind the enamel to a fine powder in a mortar, and apply it wet to the metal where required—then fuse all together at a red heat, either by blowpipe or furnace.

The earliest enamels existing are now t found on some of the pieces of exquisite jewellery made by the Greeks and by Etruscans about the 6th century B.C. T enamels are small and accessory to the fi work in gold ever made. Little shallow sp were outlined by means of a fine twisted wire soldered on to the metallic groundw and into these "cloisonné" spaces the ena were fused, most likely by means of a b pipe.

The colours used are dull blue, dull green, and white. Besides these little cloisc pieces there are also found among the Etrus jewellery several instances of earrings small pendant figures of animals and bird white enamel fused on a gold wire fashio in a proper form, after these there are enamels to be found for a considerable t Whether the art was lost or whether sir the examples of it have been lost I cannot but there seems to be no trace left of it we come to the 3rd century A.D., whe Greek writer, Philostratus, in a work ca the "Icones," mentions variegated h trappings, and writes: "They say that Barbarians who live in, or by, the ('Εν ὠκεανῷ) pour colours on to heated br and they adhere, become as hard as stone, preserve the designs which are made in the This undoubtedly refers to vitreous ena and moreover it seems very likely that it refers to Britain, as the dwellers in an isl might well be described as "living in sea," but some authorities think the Gauls intended. Although we now have no insta of enamelled work done in Britain so earl the 3rd century, there are many specime house furniture belonging to the late C period which show clearly enough that objects were in all probability commonly m On these the colours are simple, dull red, blue, and dull yellow being almost al found. Specimens have been found in Y shire, Somerset, and Norfolk particularly.

In Ireland were made beautiful cups, shri and bell-covers, ornamented with enamels niello work at a very early date, the Ar cup being perhaps one of the finest pieces it is supposed to date from the 9th or century.

The Romans brought the art of ename on bronze with them, and practised it lar here up to the 5th century—(Romans Britain 436)—and after them, what ma called the Anglo-Roman work, nearly re bling the actual Roman, continued for

e, the colours being dull red, dull blue, green, and white rarely. These mels are usually on small objects—læ or brooches, pins of various kinds, ls, and numerous small articles of little stic merit. Some of them appear to have n made of brass (copper and zinc) and ie of bronze (copper and tin, with some-es phosphorus, manganese, lead, or zinc), l they appear in many cases to have been t cast from a mould, and subsequently shed with a graver, in the champlevé nner, in preparation for the enamel. The nze pieces often have a beautiful green ina upon them.

From the 5th century, until the coming of Normans, during the Anglo-Saxon period, ch beautiful jewellery with cloisonné work s done here, probably by Celtic workmen. At t sight much of this appears to be enamelled, actually it resembles the Egyptian work of character, the cloisonné spaces being filled h accurately-cut pieces of stone, glass, or nposition, kept in place either by some ong cement underneath, or else by the ght projection of the upper edge of the ison itself. Generally, if the cloisons lose *deep* hollows, this inlaid work may be pected; but if the hollows are *shallow*, they more likely to have been enamelled.

During the reign of King Alfred, in the 9th ntury (879-896), it is possible that a much er kind of enamelled work than any that d preceded it in these islands was produced. ere are now, I believe, only four speci-ns of this work left, and they are fine in-nces. One is at the Ashmolean Museum Oxford, and is known as the "King Alfred's wel;" round the setting is a legend, saying, Alfred caused me to be made;" the other ee are in the British Museum, one known the Dowgate-hill brooch, because it was nd there. It bears the crowned portrait of ing, supposed to represent Alfred himself. other, known as the Hamilton brooch, cause it belonged to Sir Wm. Hamilton's lection, has a charming conventional de-n in the centre; and the last bears a nale bust, the enamel of which is dis-oured by time. All these are most skil-ly and beautifully worked in the finest isonné manner, and many of the colours translucent; the three brooches in the itish Museum are, moreover, set in gold, o of them with pearls. They are pieces of vellery of which any nation may be proud, d, moreover, they are amongst the very earliest existing enamels in which any attempt at portraiture has been attempted. Even if the Alfred Jewel and the female bust brooch are not meant for any particular person, there seems to me little doubt that the Dowgate-hill brooch is intended to represent an actual king, as it is crowned with a similar crown to those which are shown on coins of about the same time.

All the fine arts received a stimulus under King Alfred. There is a tradition that he sent Bishop Sigelin to India. T is expedition brought back stores of treasure, precious stones, and jewellery of various kinds, the study of which is supposed to have encouraged Alfred's goldsmiths, who are said to have worked under his personal supervision, a supposition to some extent sup-ported by the words on the edge of the setting of the Alfred Jewel, "Aelfred me heht gewurkan."

I will first show you slides of two pieces of metal work that have no enamel or inlays left in them, but which will make more clear than any words the meaning of the terms, "cloisonne," "champlevé," and "basse-taille."

II.—Byzantine.

The school of enamelling to which I shall now draw your attention, is that known as the Byzantine, remembering always that this term must be considered to represent a style, rather than only such work as was actually done at Byzantium, a style moreover which spread widely, and had great influence for a long time in the entire world of art.

Byzantium was an ancient city of Thrace, founded by a Greek colony under the leader-ship of "Βύζας," whence its name, in the seventh century B.C., but it did not arrive at any im-portance until about 330 A.D., when Constantine the Great made it his capital, and called it after his name, when Constantinople became the centre of the Byzantine or Eastern Empire.

The Byzantine school of art developed from the classical during the fourth and fifth cen-turies A.D., and flourished until the conquest of the Empire by the Turks in 1453, and the more nearly it approximates to its Greek original, the finer it is.

The style spread largely, and its iufluence strongly survives, even to the present time, in Russia. It is always rich in colour, often to an exaggerated extent, and the Byzantine workmen are said to have jealously guarded the secrets of vitreous enamelling in metal

until the latter half of the eleventh century, after which the knowledge became widely spread, owing partly to the migration of their own workmen, and partly to the incoming of foreign workmen, who took the knowledge back with them to their own countries.

The very early Byzantine enamels which still exist are largely figure subjects, and in all probability those which preceded them, if there were any such, were of the same character. It is very likely owing to this that nothing now remains to which an earlier date than the tenth century can with any probability be assigned. This is supposed to be about the date of the small pectoral cross or reliquary which formerly belonged to the Beresford Hope collection, and is now in the British Museum. It is very delicately cloisonné, and bears representations of Christ, His Mother, and Saints.

An explanation of the disappearance of the very early Byzantine enamels may be found in the existence of a curious sect or party founded in the Eastern Empire by the Emperor Leo the Isaurian, and continued by his immediate successors, Constantine Copronymus, Leo the Armenian, and Theophilus. This sect was called the "Iconoclasts," and their mission was to destroy all images of any kind wherever they could find them. They lasted until the ninth century. It is very likely that in the churches were many enamels of saints and holy personages, and it is quite possible that the Iconoclasts made practically a clean sweep of them.

There is fortunately one magnificent piece of enamel work still existing, which makes it easy to realise that the Iconoclasts may have had full provocation for the destruction of such treasures. This is known as the "Pala d'oro," and is the back of the altar at St. Mark's Cathedral at Venice. It is about 11 feet long by 5 feet in height, and consists of a silver-gilt framework, richly worked, and studded with jewels, set, moreover, with enamels of different dates and sizes, portraits, saints, and scenes from Biblical history.

The two largest enamels represent our Saviour and the Archangel Michael, and parts of both of these are in relief and jewelled, the relief pieces being added after the enamels were finished. In the lower part are two most interesting figures, one a portrait of the Doge Ordelafo Faliero, and the other the Empress Irene. There are also two panels of silver with engraved inscriptions which seem to have been added about the 14th century. These inscriptions tell us that—(1) Under the Doge Ordelafo Faliero in 1105 the Pala "N[...]a facta fuit," and that under the Doge Pi[...]o Ziani in 1209 it was "Renovata;" (2) T[...]t under the Doge Andrea Dandolo in 134[...]t was restored, "Novatur."

So from its own evidence we gather t[...]t it certainly was older than the date of [...]e Doge Ordelafo Faliero, and it further appe[...]s from the ancient chronicles of Venice that [...]n the 10th century the Doge Pietro Orse[...]o (976-977) ordered a "tabula" to be m[...]e for St. Mark's, which is supposed to be [...]e Pala, but Francesco Sansovino in his b[...] on Venice says that it was not actu[...]y brought there until the 12th century.

No doubt the Doge Ordelafo Faliero alte[...]l the Pala considerably, and one of the anci[...]t enamels of a Byzantine emperor has b[...]n newly lettered with his name in Latin, an[...]n other ways changed especially as to the cro[...].

There has been considerable difference [...]f opinion among experts on the question wh[...]h of the Byzantine emperors this figure origin[...]y represented. Ludwig Pasini thinks it m[...]y have been John Comnenus, as the co[...]panion figure is that of an Empress Irene, [...]e name of his wife, who was a daughter of K[...]g Ladislas, King of Hungary. It is, howev[...], equally likely that it represented the Emp[...]r Alexis Comnenus I., whose second wife [...]s also named Irene. The enamel of the Empr[...]s still has its original inscription in Greek, [...]d has not been so much altered as the other. [...]t is a figure full of dignity, and, I think, may [...] considered one of the finest Byzantine enam[...]s existing.

The peculiarities of the royal dress of [...]e Byzantine emperors are admirably shown [...]n these two figures, and it is interesting to n[...]e how they are almost in exact corresponde[...]e with the figures of an ancient crown which [...]s discovered in 1860, in a field at Nyitra-Tran[...], in Hungary. The plates of this crown [...]e seven in number, and are of different si[...]s, rounded at the top; the largest is ename[...]d with a portrait of the Emperor Constantine [...], called Monomachos, the two next largest [...]s wife, the Empress Zoë, and her sister Th[...]dora, the remaining enamels being of [...]o dancers, and allegorical figures of Humi[...]y and Truth. The date of it is about the mi[...]e of the 11th century; the Emperor died in 10[...]. These plates doubtless formed part of a cr[...]n designed after the Byzantine fashion, the [...]st existing example of which is the crown [...]f Charlemagne, now in the Royal Treasury [...]t Vienna.

bsequent researches resulted in the discovery of fragments of jewelled edges and miscellaneous pieces, by the aid of which the antiquary, Franz Bock, has made a restoration of the complete crown.

Besides these, I have to show you a few Byzantine enamels on bookbindings, and, as well as the crown of Charlemagne, already mentioned, there are fine plaques of a similar style on the very curious crown of Hungary, at Buda-Pesth.

III.—LIMOGES AND FRANCE.

At Limoges, a town of central France, there began in the 12th century an output of enamelled work, which lasted until the 18th century. There is documentary evidence of such work having been made at the earlier date, and, what is more to the purpose, a few actual pieces have survived, and during the 13th century particularly there was a very large production of ornaments of the altar, shrines, reliquaries, pyxes, crucifixes, candlesticks, crosses, horse trappings, sword pommels, belts, and a host of other miscellaneous objects of use as well as ornament. This work was known as "Opus Lemoviticum," or "Opus de Limogia."

The enamels used were, as far as I have observed, always opaque, and they were applied to thick copper in the champlevé manner. Designs are frequently repeated, a sign that the commercial value of these enamels was at all events not lost sight of.

It is possible to make a rough classification of the earlier Limoges enamels, chiefly by means of the different manners of treating the backgrounds, and also by the manner of treating the figure-subjects.

In the twelfth century the backgrounds were in gilt metal, with delicate engraved designs, the figure-subjects in enamel.

In the thirteenth and fourteenth centuries the backgrounds were enamelled, generally in dark blue, and the figure-subjects were in gilt metal, either engraved or in partial or whole relief.

During the whole of this time some of the enamel colours were allowed to gradate into each other without the interposition of a metal boundary line. The colours which are treated in this way are usually in small bosses, flowers, or monumental scrolls; they are arranged in two sets—deep red, dark blue, light blue and white, and dark blue, green and yellow. This merging is not, however, to be considered as an absolute sign of Limoges work, as it also occurs on German enamels of an early date, the blue gradating to white, and the greens to yellow.

Towards the end of the 14th century a lull came over the large production of enamels from Limoges, possibly to some extent due to over-production, but also to the growing appreciation of works of art in ivory, the precious metals, and other media; but during the latter half of the 15th century a remarkable reaction set in, not that the old champlevé manner of working recovered its lost ground, but a new, freer, and more artistic method came into existence. This is known as the "painted" style, and in it the copper is left plain, the enamels being applied direct upon it. The painted enamels are in two distinct manners, one known as "grisaille," and the other in rich colours. In the case of the grisaille enamels the surface of the copper is all covered with a very dark enamel, and on this the design is "painted" in white, layer after layer, thick in the high light and thin in the shadows. On these enamels there is here and there a little red or flesh colour, and a liberal use of fine gold painted lines and scrolls. One great value of the painted gold lines in enamel work is that as it alone looks the same before firing as it does after, the artist can accurately judge the effect he is producing. The painted enamels in colour are, so to speak, inlaid side by side, or, in some cases, where special parts are required to be particularly brilliant, shaped pieces of gold or silver foil are applied with translucent enamels over them, the rest of the enamel being finished first. On these coloured enamels there is also a free use of painted gold lines and scrolls, often used to mask the lines of junction of the different colours, which are likely to show accidental defects, and to some extent run into each other.

A convenient classification of the painted enamels into three styles was suggested by Sir Wollaston Franks, *i.e.* :—

1. The "Early Style," from 1475 to 1530.
2. The "Fine Style," from 1530 to 1580.
3. The "Minute Style," or the decadence, from 1580 to the close of the manufacture in the 18th century.

The peculiarities of these three styles may be briefly described as follows:—

1. The "Early Style" (1475-1530) was on thick copper, nearly flat, the whole surface being smoothly covered with a very dark, nearly black, enamel; in this the design, as I have already mentioned, is painted in white enamel, with traces of colour and gold lines. Some-

times large pieces of foil under translucent enamels were used in such enamels as were also painted in colour, but these paillettes are never used with grisaille work alone.

2. In the "Fine Style" (1530-1580) the copper is much thinner, and there is a marked Italian influence seen in many of the designs. Large pieces of foil under translucent colours were discontinued, but the use of very small pieces of jewel-like form and arrangement called "paillons" came into use. Artists of the family of Penicaud used these "paillons" freely, they also frequently stamped the letters "P.L." on the copper of their enamels—probably standing for "Penicaud Limousin." The paillons are not much more satisfactory than their predecessors the paillettes, as in both cases the translucent enamels have a special tendency to chip off, and otherwise fine enamels are often spoilt by bare patches caused by the disappearance of these accessory pieces, colour and foil as well.

To the "Fine" period belongs the greatest enameller whose name is known, "Leonard dit Limousin, Esmalieur peintre, valet de chambre du Roy." His earliest signed work is dated 1532, and his last 1574. His work took many forms, vases, cups, chessboards, dishes, &c., but the most important are the wonderful series of portraits, generally the bust only, of the most notable personages of his time in France, ranging from King Francis I. and his Queen downwards. The frames of many of these portraits are also often ornamented with small enamelled plaques.

There are several other names of note among the Limoges enamellers of this time, among them may be mentioned Pierre Raymond, who usually painted in grisaille with slight colour and gold; Jean Courtois, who used "paillons," and produced an especially fine black for his background; and Pierre Courtois, whose figures are beaten out in relief before the enamelling is done. Jean Court, dit Le Vigier, worked largely in grisaille with slight flesh colour, and is known to have made caskets his especial study.

3. The "Minute Style," or as it may well be called, the decadence, began about the end of the 16th century. It is marked by finical execution, probably due to the discovery of a new medium which would carry the metallic colours—resembling what we now call "oil colours." Susanne Court worked faces in profile, finished freely with fine gold painted lines, and the Limousins (Jean, Léonard, Joseph, and François) all made small works, the designs on which are freely taken from co[n]temporary prints.

After 1620, the Limoges enamels lost grou[nd] rapidly, the best work of the period bei[ng] produced by artists of the family of Landi[n]; these enamels usually have brilliant bla[ck] background, and in the 18th century, t[he] manufacture, as an important industry, ca[me] to an end.

Limoges was not the only place in Fran[ce] where enamelled work was made. From so[me] workshop in Southern France comes t[he] splendid gold cup, now in the British Museu[m] known as "St. Agnes Cup," as it bears t[he] history of that saint upon its sides and lid, [in] basse-taille with translucent enamels. It [is] the finest existing specimen of this kind [of] work, and is supposed to have been ma[de] during the 14th century.

During the 17th and 18th centuries t[he] minute style of painted enamels, used p[ro]bably with an oil medium, developed larg[ely] in the direction of watch cases, and exquis[ite] work of this kind was done by several arti[sts] or note, in latter times much of it being ma[de] at Blois. I regret I have no slides of the[se] to show you; the finest work of this kind [I] have yet found are by Toutin, Dura[nd,] Muisard, Camille André, Bouvier, Moliè[re,] Vauquer, Petitot, Bordier, and Zinc, wh[ile] for quite modern French work that of [M.] Fernand Thesmar is perhaps most to [be] noted, the skill shown in his work in Plique [à] jour being quite wonderful.

IV.—Miscellaneous.

Besides the three large divisions into whi[ch] I have divided my slides there are many ot[her] schools of enamelling to which I can o[nly] draw your attention by means of a few sin[gle] examples.

In Italy and Germany the art is old, but [in] the rest of my miscellaneous slides you [will] only see comparatively modern work.

The best Japanese work was done during t[he] last century, and is, I think, unequalled [for] minute working of cloisonné enamels; [for] delicacy of workmanship and intricate desi[gn] they have never been equalled. The mod[ern] Japanese work is in all technical ways maste[rly] to the last degree, but the design is usua[lly] weak.

English work in enamels has found a wor[thy] champion in our member, Mr. Starkie Gardn[er,] and, as he says, no doubt whatever a care[ful] examination would reveal many treasures [of] home production which are now credited [to]

eign workmen. What we know is fine, but re is still to be known. The Garter plates at indsor range from the 14th century onwards, d in the same century and during the 15th re was a large production of enamelled ›ziers, usually silver gilt, cups, ornaments of nbs and sword pommels, some of them with nslucent enamels. At Oxford and Cam- dge, and at many other places are pre- ved several splendid cups, exquisitely ought in silver as a rule, and with enamel aments.

During the last century there were the manu- tories at Battersea and Liverpool, from both of iich there was a large output of small articles. iese are on copper, covered all over with a oundwork, usually white, on which designs e painted in "oil colours," and sometimes inted. The best of these are probably the ndlesticks, some of which are graceful ough. The enamels vary considerably in tistic value, but generally they are not rticularly good.

There is to-day a revival in England of erest in the beautiful art of enamelling. e have been fortunate of late years in having d the opportunity at the Royal Academy, South Kensington Museum, and elsewhere examining and appreciating the fine work ne in this medium by artists such as Messrs. o. Frampton, Hubert Herkomer, Alex. sher, and Nelson Dawson, and also a helping nd of great value has been given by the cellent technical school of arts and crafts der the auspices of the London County uncil.

It is only of comparatively late years that fine amels have been made in India, among other aces, at Lucknow and at Jeypore, the last ing remarkable for the fine ruby red (oxide gold) in a gold ground work.

At Partabgarh, a peculiar kind of enamel made, designs cut out of thin gold are in- id in a dark green ground work.

At Damascus and other places in the East easy and very effective way of producing amels apparently laboriously made by means champlevé work, has been hit upon. The itline of the design is simply repoussé m the back of the copper, and the hollows us made on the other side are roughly filled th opaque enamels.

In Russia, a considerable quantity of enamel rk is done on silver and copper. It is ually cloisonné, but sometimes painted on a in enamel groundwork, always in opaque lours; most of it is not earlier than the last century. The cloisons are variously produced by soldering, casting, or repoussé work.

Charming work in Plique-a-jour is done at the present time by I. Tostrup, of Christiania, and by M. Hammer, of Bergen, often in bowls and spoon-handles.

During the last century many small enamels, snuff-boxes, candlesticks, &c., were made at Dresden.

The paper was illustrated by a series of lantern slides of the different classes of enamels, coloured by Mr. Davenport, as follows:—

EARLY ENAMELS.

1. Gold armlet from the Oxus, with cloisons and champlevé work. 2nd or 3rd century B.C.
2. Silver Italian medallion showing basse-taille work. 15th century.
3. Greek necklace with enamels. 5th or 6th century B.C.
4. Etruscan enamelled earring. 5th or 6th century B.C.
5. Late Celtic horse's bit, from Hull.
6. Late Celtic helmet, found in the Thames.
7. The Ardagh cup. Celtic work. 9th or 10th century A.D.
8. Anglo-Roman enamelled plate.
9. Anglo-Roman enamelled brooches.

Celtic, under the Anglo-Saxons.

10. The "King Alfred Jewel," enamelled portion. 10th century.
11. The "Dowgate Brooch." 10th century.
12. Brooch with portrait of a lady. 10th century.
13. The Hamilton Brooch. 10th century.

BYZANTINE ENAMELS.

14. Reliquary. 9th century.
15. Bookbinding. 9th century.
16. Plaque. 10th century.
17. Bookbinding. 9th or 10th century.
18. Plan of the Pala d'Oro. 10th century.
19, 20, 21, and 22. Enamels on the Pala d'Oro.
23. Crown of Constantine Monomachos. 11th century.
24. Crown of Hungary. 11th century.
25. Crown of Charlemagne. 11th century.
26. Bookbinding. 11th century.
27. Earring. 11th or 12th century.

LIMOGES ENAMELS.

28. Plaques of the Virgin and St. John. 12th century.
29. Bowl, by G. Alpais. 13th century.
30. Bookbinding. 13th century.
31. Casket. 13th century.
32. Candlestick.. 13th century.
33. Plaque, by Nardon Penicaud. c. 1503. (Early style of painted enamels.)

34. "Charles Tiercelin," by Leonard Limousin. c. 1540.
35. "Sibylla Europa," by Leonard Limousin. c. 1550.
36. Plaque, by Jean Penicaud. c. 1540.
37. Ewer, by Pierre Raymond. c. 1540.
38. Plaque, by Pierre Courtois. c. 1560. (Figs. 34, 35, 36, 37, and 38 are examples of fine style of painted enamels.)
39. Purse, by J. Laudin. c. 1690. (Decadence of painted enamels.)

MISCELLANEOUS ENAMELS.

40. German medallion. 12th century.
41. St. Agnes' Cup. 14th century.
42. German cup with with "Plique-a-jour." 15th century.
43. German spoon. 15th century.
44. Italian plaque. 15th century.
45. Italian pendant. 16th century.
46. Persian dagger. 17th century.
47. Chinese vase. 18th century.
48. Japanese sword-guard. 18th century.
49. Jeypore dagger. 18th century.
50. Jeypore dagger. 18th century.

SUPPLEMENTARY SLIDES OF ENAMELS.

Shown on a table screen.

1. Greek necklace. About 600 B.C.
2. Celtic bronze shield with enamelled bosses.
3. Anglo-Roman vase, found near Ambleteuse.
4. Late Celtic armlet with enamels.
5. Byzantine bookbinding. 9th century.
6. Byzantine bookbinding. 10th century.
7. Byzantine cup with enamelled rim and foot.
8. Byzantine cup with enamelled inscription.
9. Byzantine bookbinding. 11th century.
10. Limoges crozier head. 13th century.
11. English bookbinding with enamels. 1570.
12. Italian jewel. 16th century.
13. Italian jewel. 16th century.
14. Spanish jewel. 16th century.
15. English bookbinding (in gold) with enamels. 1590.
16. English candlestick. 17th century.
17. English candlestick. 17th century.
18. Russian candlestick. 17th century.
19. Jeypore dagger. 18th century.
20. The iron crown of Lombardy.

DISCUSSION.

The CHAIRMAN, in proposing a vote of thanks to Mr. Davenport, said he had not listened to a more interesting paper tor some years. Not knowing much about the subject previously, he took the precaution of reading the article on "Enamels," in the "Encyclopædia Britannica," and this paper had whetted his appetite still more.

Mrs. NEWMAN said the ground had been so w covered by Mr. Davenport that there was very li more to say. She had been particularly interested the remarks about the Greek and Etruscan jewelle in which little bits of enamel were let into the g work by means of a blow-pipe. That was one of most interesting ways of enamelling even now, a produced very beautiful effects. She could pro however, that it was quite possible for English wo men to do as fine work as any of the Etruscan for much is done. She would not say the desig were original, because they were generally copies, a there were English workmen doing gold work as fi and delicate, and in as good relief, as anything sho in any museum in Europe.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., sa he could not leave the meeting without first givi hearty expression to his gratitude toward Mr. Cy Davenport for the valuable and most interesti paper with which he had favoured them. Mr. Cy Davenport was doubly a master of his subject by his comprehensive and intimate knowledge of and his wonderful artistic skill in illustrating Nothing like his accurate and vivid photo-chroma reproductions of the objects illustrating his pap had ever been seen before; and he only hop that Mr. Cyril Davenport would soon either edit revised reprint of some such standard illustrations enamels as those given in Du Sommerard's *Albu* or bring out a book of his own on the enamels of ages and all countries, not omitting the enamels India (Jeypore, &c.), illustrated from the truly magic "lantern slides" with which he had charmed the that evening. He must say that he sympathised wi Mrs. Newman in her protest against Mr. Cyril Daven port's unqualified condemnation of the English peop as art workmen. Rather he would condemn our i discriminating insistance on cheapness; and t much abused "British workman" was to be co mended for graduating the skill he put into his wo by the wage he received for it. There was, in trut nothing in the way of technical dexterity the Briti workman could not achieve if he was paid for properly. What had very forcibly struck him in M Cyril Davenport's exquisite and brilliant illustr tions was the proof they afforded, at a glanc of the absolute unity of the decorative arts the Old World, and of their unbroken antiqui from the date of the ancient Egyptian, Assyrian, a Babylonian Empires, to that of the introducti of the use of machinery in their production (i. machination) in Europe, and down to the prese day wherever the handicraft arts still survive in As This unity and continuity are especially conspicuous the altars, the eucharistic vessels, the sacerdotal ve ments, and the ecclesiastical furniture generally, of t Eastern and Western Churches, and in the traditiona regalia of the older kingdoms of Christendom. T eight-sided "crown of Charlemagne," enriched wi opaque cloisonné enamels, and studded with glowi

ious stones, which Mr. Cyril Davenport had oduced with such startling reality, was crown of the German Emperor, the crown ie Czars of Russia, and the parcel gilt crown he Negus Theodore of Abyssinia in the South isington Museum, and the golden crown, *i.e.*, *taga* he Abuna [labelled Abima] of Abyssinia, in the e museum; and these all go back to the imperial vn of the Byzantine Cæsars; and this to the tiara-domed crown of the Assyrian kings of the neveh Marbles;" which is almost identical with the llic tiara of the greater gods of the Hindu theon. And all these evidently originated in cap which the terra-cottas of Cyprus show was n by the priests of Venus, and which was identical the cap of the Roman augurs, with the *cidaris* henaeus) of the ancient Persians, with the so-called ygian cap, and with the *taj* of the modern India, the *fez* of Turkey. In another form, that of a sely-folded turban, it was the "ephod" of the orews, and one of Mr. Cyril Davenport's illus-ions, showing a patriarch in "amice" (super-ieral) and pectoral, threw a strange light on puzzling connection between the "ephod" and Hebrew "breastplate of judgment." The amice, Latin amictus, "head-wrap," "kerchief," is the inary Bedouin yellow and green *kaffia*, which in its plest form is a fine cloth (*immeh*, and, as worn the women of Egypt, *farudiyeh*) thrown lightly r the head and shoulders; as in Milton's lines:—

> "Morning fair
> Came forth with pilgrim steps, in amice grey."

ien twisted round the head, as the "ephod" , it is called in Hindustani *shamlah* [c.f. *shamiana*, canopied sun-screen under which *darbars* are d in India]; and in some unexplained spiritual nificance it is also called in Arabic *tilsam*, *i.e.*, 'talisman" [Greek, *telesma*], which associates it h "the helmet of salvation" of Isaiah l., 17, hesians vi., 17, and I. Thessalonians v., 8. Here n undoubted suggestion of a solution of the riddle the confusion of the ephod with Aaron's breast-te, and the Urim and Thummim, in Exodus xxviii., viticus viii., &c. It appears also in sacred legend "St. Veronica's handkerchief," and in heraldry as "mantling" about helmets—the "*pugri*-cloth" und round "*s(h)ola*r *topis*." Only by a reference to East can we ever hope to clear up the many scurities that obstruct our research into the origin the ecclesiastical vestments and religious symbolism the West, and directly we turn to the East light gins to flow in on our darkness. "Ex Oriente Lux" that is the moral of all thoroughly detailed and haustive expositions of Western art, such as that th which Mr. Cyril Davenport has instructed and lighted them that evening. He heartily seconded vote of thanks to him moved by the Chairman.

Mr. Lewis F. Day said he must say something praise of the beautiful illustrations accom-nying the paper, which enabled one to appreciate the objects much better than mere black and white reproductions. It was wonderful how closely they approached the colours of the originals; he would not say they were actually facsimiles, for he did not think that was possible; but those who knew the things themselves could say how nearly they approached to them; and those who had tried to colour slides would wonder most at Mr. Davenport's success. He should like to ask two or three questions. In the first place, with regard to the "Alfred Jewel," if the inscription said "Alfred made me," why should not Alfred be the name of the maker? Was there any documentary evidence on the point? He would also like to know where the book-cover with the border was, which Mr. Davenport said would have been more interesting if it had been enamelled; to him it was more interesting because it was not enamelled, but inlaid with bits of glass. The connection between those two things was very interesting; he thought enamelling was probably an imitation of glass inlaying, and glass inlay an imitation of jewellery. With regard to the early Limoges enamels on copper gilt, would Mr. Davenport tell him if the enamel was put on over the gilt. He must demur to the statement that enamel in baisse-taille was the most artistic. It gave more scope for finiking detail, but not necessarily for higher art. In his judgment a bolder style, which did not depend upon modelling under the enamel, was more artistic. The simpler such kind of work was the better. He could not see where the extraordinary artistic value of the St. Agnes Cup lay, though he had tried again and again. It was a most wonderful piece of enamelling, but difficulty did not make art. One other question. Could Mr. Davenport account for the difference between the colouring of Japanese and Chinese enamels? They were done in the same way; but the Chinese were more brilliant, and generally bright in tone. It might be said that it was due to a difference in the national characteristics; but he thought it was more probably due to a difference in the materials used. In looking at the work shown a while ago at the Burlington Fine Arts Club, he noticed that the colour of some quite early mediæval enamels, which he understood were English, was very much like the Chinese, so much so as to deceive even an artist at a short distance, though close inspection would reveal the difference of detail, and he thought that resemblance must arise from using the same material and working in the same way. Early British enamels, which were again not bright, were perhaps somewhat lowered in tone by age.

Mr. Starkie Gardner said Mr. Davenport had given them a wonderful series of illustrations, which he did not think anyone else could have produced, and the labour of preparing such a series of slides must have been immense. To see them was as good as seeing the enamels themselves in some respects, as they were magnified very considerably, and in many

cases the originals could only be seen in museum-cases, where the details could not be examined. He was delighted to find that Mr. Davenport recognised that the series of Anglo-Saxon enamels were really Anglo-Saxon and not Byzantine. One of the brooches shown was found in Italy, and it was a great argument against the other two being Anglo-Saxon that they were so much alike, and Sir Wollaston Franks himself used that argument, but he could not see the force of it; and most people now agreed that there was an Anglo-Saxon school, which differed considerably from the Byzantine. The fact that the Alfred Jewel bore the name of Alfred was a strong proof that it was of English origin. Many rings and other articles bore a name, but in all cases he believed it was the name of the person for whom it was made, not of the actual workman. There were many more beautiful enamels than those shown, many bowls and cups were far more beautiful. There was no doubt they were of British origin, and, in fact, this was probably the only nation then working in enamel. As a rule, similar works of the same date made abroad were inlets of glass. The low tone of colour to which Mr. Day had referred was due, he believed, to the fact that they were enamelled on cast bronze, and the zinc or tin in the bronze got into the enamel and stained it. That did not apply to the translucent Japanese work. He hoped some day Mr. Davenport would take the trouble to make a slide or two of some of the rarer German enamels, and also that he would collect some of the many beautiful Elizabethan enamels which were scattered about the country, and had never been seen together; some of them were beautiful little arabesques, which were quite peculiar in this country.

Mr. Cyril Davenport, in reply, said he should agree with Mrs. Newman with regard to enamel work, but what he referred to was the Etruscan gold work. He had good authority for saying that both Tiffany, of New York, and Guiliano had tried their best to get similar work, but in vain. He had been much interested in what Sir George Birdwood said about the Abyssinian and Babylonian crowns, and should endeavour to study that point more. He showed the bracelet from the Oxus as a specimen of cloisonné and champleve work; the one he had shown was the one at South Kensington; he knew there was a duplicate in the British Museum. South Kensington gave £1,500 for it. He should say the gilding on the Limoges enamels did not extend under the enamel. The "Alfred Jewel" was of course doubtful, but it was a beautiful thing, and was carefully preserved. It was probably the top of a sceptre, because there was a socket with a pin in it, and no doubt originally had a handle; the figure in the enamel held two sceptres. Mr. Starkie Gardner was right in saying that the workman rarely put his name; any name that appeared was generally that of the owner. Workmen's marks came later. The St. Agnes Cup he did not like to abuse, as he was officially connected with it. It would take too long to go into the dif[ferences] between Chinese and Japanese enamels. [He] had been obliged to omit a great deal, not only w[ith] regard to German enamels, but also English, for, [as] a matter of fact, any single division of the sub[ject] would afford material for over an hour's lecture.

TWELFTH ORDINARY MEETIN[G]

Wednesday, March 1, 1899; Profes[sor] John Millar Thomson, LL.D., F.R.[S.], Member of the Council, in the chair.

The following candidates were proposed [for] election as members of the Society:—

Brooks, Christopher P., New Bedford, Ma[ss.], U.S.A.
Butler, Joseph Margerison, 33, Dorset-street, P[ort]man-square, W.
Clare, Harcourt E., Liverpool.
Davies, Dixon Henry, Chesterfield.
Drummond, C. J., St. Bride Foundation, Bri[de]-lane, Fleet-street, E.C.
Fullerton, Major John Davidson, R.E., Br[ine] Baths Hotel, Nantwich, Cheshire.
Lloyd, Edward Honoratus, 5, Crown-office-r[ow], Temple, E.C.
Norton, Robert, Coombe Croft, Norbiton, Surrey.
Radcliffe, F. M., Liverpool.
Ward, Septimus H., Shirle-hill, Sheffield.
Writer, N. N., 7, Beverley-road, Anerley, S.E.

The following candidates were balloted [for] and duly elected members of the Society:—

Hawkins, Bernard, 123, Victoria-street, S.W., [and] Bangalore, S. India.
Lazenby, Walter, Castlebar, Sydenham-hill, S.E.
Lewis, Valentin Townshend, Dene Hollow, Burg[ess]-hill, Sussex.

The paper read was—

LEADLESS GLAZES.

By Wilton P. Rix.

The use of lead in pottery is most proba[bly] coeval with the use of glaze. If the adoptio[n of] bitumen and of cerates, to obviate porosity, [be] considered the first advance, their aband[on]ment in favour of a material requiring ard[ent] heat for its fusion certainly marks the sec[ond] and the more important change. Though [in] time the potter discovered the use of alkal[ine] glazes, there is little doubt that lead [ore] sprinkled on the ware gave the first suggest[ion] and the first desire for the permanence of [his] wares. Through the ages lead has ever h[eld] the foremost place amid all the changes [of] form, and colour, material, or decoration, fac[e]

s results, brilliant in its effects, yet ever ous in its influence on human life. Egypt Assyria have both left examples of supreme mic skill, in which the admixture of lead played a leading part, this gives evidence no mean intelligence in the craftsmen of e days.

here have always been those who in their dicraft are thus intelligent and observant, , moreover, have nursed the incentive to pass their fellows. Nor have there been iting many also who, for the considerations self, were willing to remain ignorant and mbitious, satisfied merely to follow their ers' track, and justify their path on this ount. But new days bring new problems. potter of the present is faced with fresh iculties and impelled to new efforts, and the least of these is the subject which com-nds our attention this evening. Its solution st finally rest with those men of enterprise ong us to whom the mention of a need is the incentive to attainment.

hough it is a fact that lead has held its so long, the use of glazes free from lead no new practice in ceramics. The hard celain of the Orientals, so long the un-ained ideal of the Western potter, dates far k into the early centuries as an example such productions, while the Rhodian and Persian" wares afford the altogether different e of soft alkaline glazes, yet still free from d contamination.

Coming to more modern times, we have the mian ware of the Roman era, probably the nplest type of glaze known, and certainly surpassed in many points by any modern al. Scarcely differing in construction are salt-glazed wares of Staffordshire, also oduced without lead. Nor must the beautiful amples of early Sèvres porcelain be omitted m the series of leadless glazes, which sufficiently comprehensive in its range, d of which I am glad to be able to show ecimens.

The importance of the elimination of lead m all glazes needs no demonstration. The tention lately called to its deleterious effects, d the statistics which have been published specting them, make it necessary for the lfare of the industry that every means should taken to reduce, if not finally to eradicate, e cause of such serious results.

The total number of persons employed in ttery works throughout the country is over ,000, of which about 20,000 are under 18 years age, about equally divided between both sexes. Two-thirds, however, of the total employed in England and Wales are located in the Staffordshire Potteries, and engaged in the production of ware in which lead glazes are constantly used.

In a considerable number of potteries lead is absent, and after deducting the operatives in these we may fairly conclude that not less than 60,000 persons of both sexes are occupied in works where precautions against lead poisoning become necessary.

It is quite true that a comparatively small proportion of this total are actually exposed to contact with lead; and it is equally true that a very large number of those so exposed, work in lead processes for years, and even for life, with complete immunity. Nevertheless we have to face the fact, that to a certain per-centage of these, say about 1 in 300, the employment is eventually fatal, while not less than 1 in 8 of the workers so exposed are more or less affected by plumbism.

Such a condition of things, arising as it does entirely from the use of lead glazes, and altogether distinguishable from the loss of life occurring through the deleterious effects of dust and heat, naturally demands the best efforts of the manufacturer to rid his establishment of so insidious an enemy.

The noxious influence of lead upon the human system has been so fully dealt with lately, and the statistics of lead poisoning have been so constantly analysed and discussed to the disparagement of the pottery manufacturers at large, that it is needless to occupy time in repeating the facts. The disastrous effect of lead in certain cases cannot be too strongly stated. When developed in its most virulent form, lead poisoning is the undoubted precursor of paralysis, blindness, and death.

It is true that the number of cases in which such terrible results ensue form a very small per-centage of the whole number of workers tainted with lead; and these again form a still smaller proportion of the total number employed.

The operation of the Act of 1895 may be considered to have produced fairly reliable statistics; and though the absence of earlier data makes it impossible to compare the present with former conditions of pottery workers, there are certain facts that deserve notice.

The returns of last year giving the cases of lead poisoning reported in 1896 from the potteries are as follows:—

Dippers	78
Ware cleaners, after dippers; Dippers' assistants	78
Glost placers	70
Majolica paintresses	42
Ground layers	48
Printers' transferrers	10
Various	56
Total	382
Out of a working total of, say	45,000

There is reason to believe that the returns for the year just ended will show a marked improvement in some branches, though at present the figures have not been made known.

As might be expected the dipping, cleaning, and placing of the ware in the ovens contribute most to lead diseases, while the decorating is only responsible for one-third of this number. The increasing use of spraying processes as well as the large proportion of free lead in majolica glazes is no doubt the cause of the heavy per-centage of cases in this branch. My own experience, however, leads me to say that this is partly due to want of reasonable precaution on the part of the workers themselves. It is not too much to say that the utmost recklessness often exists among those employed. On the other hand, it is possible to point to instances such as that of the Mersey Lead Works, Warrington, in which the absolute immunity for years from lead poisoning is almost entirely attributed to the loyal co-operation of the workers in observing the regulations.

Statistics also go to prove that the employment of girls in dipping and placing is most undesirable, owing to their greater susceptibility. Of the two, placing is the most dangerous, as the glaze is dry. The peculiar susceptibility of some constitutions is also a well established fact, corroborated by many of the leading employers. Though many have worked a life time without contracting any taint, others are found who inevitably become affected in two or three weeks. For this reason, one cannot too strongly approve the adoption of the new regulations which make compulsory the monthly examination of all women and young persons employed in lead processes by the certifying surgeon, who may order suspension from employment of those affected. Such a law is most beneficial, by inducing care on the part of the worker, and promptly eliminating those of susceptible constitutions.

The necessity for such a regulation becomes sufficiently obvious from the Chief Inspector's last report, in which it is stated, in regard to the effect of lead upon maternity, that of 77 married women reported as affected by lead, only 36 had borne living children, and of these 40 per cent. had died in infancy.

Space will not allow notice of the various conditions which tend to induce plumbism. It may be sufficient to point out that they resolve themselves into two main groups :—

Want of cleanliness, both of worker and workshop ; and

Want of ventilation.

Both of these are dealt with under the new regulations, but success can only be secured by the co-operation of the workers, and it is admitted that apathy in this matter is at present the greatest obstacle.

But while the regulation of existing conditions may be important, far greater benefit must obviously accrue from the elimination of lead in pottery operations. In short, it becomes necessary to consider—

1. Whether at present, or by gradual stages, it is possible to exclude the use of lead entirely.

2. If this cannot be done, how far the regulation of its use will mitigate its noxious effects.

3. To what extent the characteristics of wares now manufactured can be modified, and public taste so educated and directed that the demands for lead glazed wares may eventually cease.

These problems are by no means new. In this country, and also on the Continent, for the last half-century at least, constant efforts have been made by manufacturers, and also on the part of the respective Governments, by means of regulation and research, to mitigate the evils referred to.

So long ago as the year 1794, the Society of Arts offered the premium of a gold medal or £30 "to the person who should discover to the Society the cheapest, safest, and most durable composition fit for use for the purpose of glazing the ordinary kinds of earthenware without any preparation of lead, and preferable to any hitherto in use."

This offer was repeated annually for no less than 25 years before anyone accepted the challenge, and it was not till 1820 that the smaller or Isis Gold Medal was awarded to Mr. J. Rose, of Coalport, Shropshire, for an improved glaze for porcelain. It will be noticed, however, that this glaze was propounded for porcelain and not for earthenware.

indeed, it has never proved itself in any satisfactory for the latter.

[It] will be interesting to those present to [know] that by the kind permission of Sir A. [Gei]ie, I am enabled to place before you this ing an early specimen of ware, glazed this glaze, from the collection in Jermyn-[Stree]t Museum, which is known to have been [prod]uced before 1826. I am also pleased to [be a]ble to place in comparison with it speci[men]s of modern manufacture from the same [pott]ery. In connection with these latter [exa]mples, the Coalport China Company make [the i]mportant statement that a leadless glaze [has] been in constant use up to the present [time], and that all services sent out are dipped [in it].

[A]s the manufacture of earthenware greatly [exce]eds that of porcelain and china, the offer [of t]he Society of Arts can hardly be said to [hav]e accomplished its purpose. It is true that [in v]iew of the fact the original offer was [cont]inued in a modified form as "Glazing [Com]mon Red Earthenware without Lead," [and] two years later the Gold Medal was [awa]rded to Mr. Meigh, of Shelton, for the [disc]overy of such a glaze, but this again could [not] be made available for general use upon [the] white earthenware body which forms the [staple] manufacture.

[N]otwithstanding the unsuccessful result of [thes]e early efforts, manufacturers have not [hav]e been indifferent to the matter. During [the] ensuing 30 years, several patents were [take]n out, and in the year 1865, the subject [was] brought before the British Association at [Bir]mingham, when Mr. H. Coghill, of New[cast]le-under-Lyne, propounded a formula which [see]med to have solved the problem of an [innoc]uous glaze. A copy of this recipe is [append]ed:—

[Cr]ystallised boracic acid (84 per cent.)..	75 lbs.
[Cr]ushed soda crystals	75 ,,
[C]ornwall stone or felspar	75 ,,
[Fl]int, ground, or silex	30 ,,
[C]ornwall clay	13 ,,
[Ca]rbonate of lime	50 ,,

[The] above to be fritted in a furnace in the [usu]al way.

[Ta]ke of the above fret	450 lbs.
[C]ornwall stone	150 ,,
[C]ornwall clay	50 ,,
[Ca]rbonate of lime	29 ,,
[Fl]int or silex	20 ,,

[The] above ground in water in the usual way, [and] stained as required.

Though persistent efforts were made to employ this glaze by some makers, they were only partially successful; and though it has been repeatedly tried, it fails to meet the demands of present manufacture. I am informed by Mr. T. Speek Walker that it was in use at Thornaby-on-Tees Pottery for some 10 or 15 years, but after making many efforts to improve it, the attempt was finally abandoned in favour of lead glazing. Uncertainty of result in firing, and consequent heavy loss, as well as the loss of brilliancy in colours, were the chief causes of failure.

At the South Wales Pottery, Llanelly, more than 30 years ago, and for long subsequently, a leadless glaze was used by Mr. Guest, but this also was finally abandoned for similar reasons. Owing to its opalinity, the colours were less bright, and the ware lower in quality, than when glazed with lead. It has, unfortunately, been impossible to obtain verified examples of this glaze.

It appears probable that some, at least, of the early wares made at Bow, Chelsea, Nantygarw, Worcester, and Derby were actually produced with lead-free glazes; but there are clear indications that for china these various potteries were unable to avoid the gradual introduction of lead for glazing purposes.

The formula for the Nantygarw china glaze has been stated in a book by Taylor, oI Shelton, date 1847, to be as follows:—

Lynn sand	8
Chalk	6
Stone	$2\frac{1}{2}$
Borax	10
China clay	40
Felspar	$3\frac{1}{2}$
Flint	$0\frac{1}{2}$
Soda	6
Nitre	3

These are fritted together.

Although the quality of the Nantygarw ware was certainly high, attempts to produce the above glaze have not proved successful, nor is it certain that it have ever been in general use.

Of the potteries already mentioned Derby and Worcester are the only survivals. It may, therefore, be well to note in passing that both at present find it necessary to adopt the use of some proportion of lead in glazing china.

At the Worcester China Works a leadless glaze of fine quality has been used from time to time and is still adopted both for china and semi-porcelain. By the courtesy of Mr. E. P. Evans I am able to show specimens of these wares. I am told, however, that though colours

stand fairly well under it the difficulties of working this glaze are considerable, the oven losses being much too heavy.

Attention has already been called to the hard felspathic glazes for porcelain, such as Chinese, Japanese, and hardware. These have usually required the exclusion of lead, owing to the high temperature at which the glost ware fire takes place.

An altogether different type of leadless glaze is to be found in the soft alkaline glazes of old Persian and Rhodian wares. Neither of these classes of lead-free glazes are of much practical value to the average commercial potter.

Most of the porcelain glazes are too hard for bodies in general use in this country. The alkaline glazes, though fusible enough, limit, by their powerful chemical action, the range of colours available. Besides this, many of them have the serious objection of instability.

In view of the facts, it is not surprising that potters have gradually succumbed before the tempting inducements offered by the use of lead glazes. Indeed, when we realise the exigencies of a market ever demanding finer finish, more perfect texture, greater billiancy of surface, as well as increasing variety of colour: and these improvements accompanied withal, by a persistent tendency to reduction in price, it is difficult to see what other course was open.

Without the use of lead, none but the most enterprising could be expected to undertake the task of supplying such demands, in face of the difficulties experienced with all other compositions, and it is much to the credit of our leading houses that they have patiently and unremittingly set themselves to solve the problem. With what success, so far, it will be one of the objects of the present paper to demonstrate, and also to show the chief obstacles surrounding it. Before doing so, it is necessary to glance at the commercial considerations which have hitherto made the use of lead almost indispensable to the manufacture as now carried on.

Foremost among these is that of economy. It is necessary that the firing temperature should be kept as low as possible to save fuel. Losses must be reduced by extending the margin of risk in every stage that will allow of it. Many bodies and glazes, admirable in all other respects, have now to be abandoned solely on this account. Unfortunately in both these directions leadless glazes stand at a disadvantage in comparison with those now used.

There are also many other points of e al importance to be demonstrated before so n-portant a change can be universally bro ht about.

The potter's art is essentially com x. Each process, though simple in itself, is o of many, all affecting the final result, and he possible combinations of which are infi e. Even when a successful result is obtain it must be proved capable of withstanding he great diversity of treatment before it ca be put on to the market.

The potter is compelled to move with cau n when leaving the beaten track, otherwis he would soon be lost in a confusion of res ts, the causes of which he would be unabl to trace.

Any changes made call for exhaustive ts as to loss in production, or failure in a al use, and these experiments may often oc y months and even years.

The manufacturer builds up the reputa on of his product by a process of selection, b ed on the survival of the fittest methods, patie ly noting those best adapted to his object. e is essentially and rightly conservative, b g well aware that all the various details of h stage are so inter-related and interdepen n that a readjustment of one may destroy e balance of the whole.

Evolution, and not *revolution*, is the wa h word of a potter, and economy dictates a among the many combinations he should i his selection to some definite treatment.

Given a certain material, the heat at w h this can safely be biscuited is limited b t composition. This, again, must define h range of possible glazes. These in their r govern the character of colour available a well as the method of production and dec a tion. Such radical departures from well-kn lines as are involved in the abandonmen lead can therefore only be arrived at thr lapse of time. Meanwhile it is possible the more complete introduction of pro fritted lead may prove a means of mitiga the evils in question, while experience is b gained for the final change.

Leadless glazes inevitably affect co used at present in a different manner, so the elimination of lead would probably in a readjustment of the underglaze colour positions, and the disappearance of some from the potter's palette, and this in itsel serious consideration.

In short, potting with leadless glaze applied to earthenware—by far the la

n of the trade—becomes practically a ıanufacture. And it is doubtful whether tempt to suit present bodies and match ıt colours is in all instances likely to ed. It is true that there are times when he best interest of a manufacturer to re-t his methods to new conditions. Such ıl changes, however, always involve large ice of plant and serious outlay. But the potter with limited capital has no margin ıch sacrifice. To him such a change if ulsory would mean ruin.

twithstanding these obstacles it is clearly uty of every manufacturer to do all that is ble, having due regard to commercial ss, towards erasing lead from the potter's f materials, and the present is an attempt ow what advance has already been made s direction.

en under the most favourable conditions hange to lead-free wares is likely to lead creased cost of production, and unless it be shown that foreign manufacturers are d under similar conditions any attempt at compulsory exclusion of lead could only the trade away from the country. In words nothing short of international lation is likely to bring about the entire donment of lead in favour of other rials.

periments have doubtless been made *ad iitum*, but from the experimental to com-ial stage is a long step. A glaze must e itself worthy over a large series of ovens, erage state of repair, and also be proved ble of standing equally in all parts of the . It must give sound texture on all kinds are. Very few leadless glazes have sur-l the preliminary ordeal, while still fewer yet entered the commercial stage. Ex-les of all these have been obtained as far ossible, and by the courtesy of the various ers are shown here this evening. In tion to these, a number of specimens of es which are promising, but not yet fully ed, are placed for comparison. I have ıer thought it well to illustrate the chief cts of such glazes by a few typical failures. may perhaps be allowed to add one or two s, giving the salient characteristics of the t important of these examples.

ext to those of Coalport, the works from factory of Messrs. Thomsberger and Her-n, of Colditz, command notice. This firm persistently given its special attention to less wares, wisely accepting, however, the tations of material. The specimens show that good effects can be obtained with under-glaze colour even in those delicate tones usually liable to be destroyed by such glazes.

In this country, the revival of attempts to abandon lead has been carried on with great energy at Minton's works, where Mr. George Leason has been successful in making a glaze suitable for earthenware. This has now passed beyond the experimental stage, and is being used on ware over all colours under ordinary conditions. It is fired without special treatment at the same temperature as lead glaze, and in all parts of the same ovens. This ware has for the last six months been thoroughly tested, both on land and sea, with very good results. It must, however, need the lapse of a somewhat longer time to make it possible to give a final verdict as to the soundness under all circumstances. Examples of this ware are on the table, from which it will be seen that the glaze is equally successful on china and earthenware. The workpeople using it, however, state that the difficulties of manipulation are greater, and in dipping especially much care is necessary.

Messrs. Doulton, with their usual enterprise, have faced the problem of non-poisonous glazes, and made an exhaustive series of experiments. The examples shown prove the glaze, when carefully fired, to be of good texture, free from injury to most colours, and equal to the requirements of the market.

Among the remaining pieces, those emanating from Messrs. Copeland's, of Stoke-on-Trent, appear to have many good qualities, and hold their own, in comparison with lead glazes, on the score of texture, freedom from injury of colours, and opalinity when very thinly dipped. As, however, the quantity of ware hitherto produced is limited, it is not yet possible to speak definitely on its merits.

The examples of ware produced by Mr. Reeves, of Fenton, are interesting, as showing the behaviour of leadless glazes upon coarser earthenwares when fired at a lower biscuit heat. The chief difficulty of working such glazes, lies undoubtedly in the comparatively low temperature of the biscuit fire at present adopted.

It appears certain that more satisfactory results could be obtained if bodies were so composed that biscuit could be fired some 100° C. (say to cone 6 or 7) than at present, thus enabling the heat of the glost fires to be increased in the same ratio. By this means a higher per-centage of alumina could be introduced into the glaze, and compounds of the felspar lime type would become available. But

the heavier cost of fuel would often preclude the use of harder biscuit. It is therefore satisfactory to find that this is not absolutely necessary to success.

Of the remaining examples which are without colour, those of the well-known factory of Villeroy and Boch, of Mettlach, claim attention. Regarding these, the makers state that, providing due care is used, they do not experience greater loss with leadless glazes, and that the treatment in firing is the same as for lead glazes. The results obtained with underglaze colours depend upon the adjustment of these as well as on the firing.

Among those producing for the general market, Messrs. Harrison and Son, of Hanley, have already shown themselves successful in furnishing leadless glazes of high quality, capable of use without injury to colours. The examples include printed and handpainted decoration underglaze, besides others demonstrating the suitability of the glaze for use with lithographic overglaze transfer. These last show the effect of second fire on the glaze, also that the texture is sufficiently smooth to receive the transfer without loss of detail.

Among those who have devoted attention to the matter, Mr. Furnival, of Stone, has experimented with some success, and examples of his most promising glazes are here shown. They have been tested with approval by some manufacturers, and they appear to have the merit of working well with most underglaze colours.

Notwithstanding the apparent success of the elimination of lead in the foregoing specimens, it must by no means be assumed that they afford decisive proof that the general adoption of lead-free glazes is yet possible. A very large range of body mixtures, fired at various biscuit heats, are now in use, and for many of these glazes without lead may prove unsuitable. It is necessary to prove whether greater expenditure in fuel is needed, and also how far the more accurate control of the glaze-dipping and firing can be met. Such a change cannot be made till the new product is shown to be free from greater expense in manufacture.

It is, therefore, still necessary as a precaution, while further experience is being gained, to find the best means of reducing the necessary lead in the present glazes, and to secure the permanent fritting of the whole.

It has long been known that the combination of the various elements in question takes place in the ratio of their equivalent weights, and unless the frit mixtures are adjusted with due regard to the combining weight, the ex[cess] of base or acid must remain in a free stat[e].

Hence the fritting of lead with silic[a,] borax or stone, can only produce innoc[uous] results when the proportions of each are [such] that the whole is chemically combined [in a] stable form. Some indications of the ef[fect] of incorrect proportions are given in the Ta[ble] appended :—

Analyses, showing amount of free lead in va[rious] frits, dissolved from 1 *part by* 50 *parts of a [solu]tion containing* 0·33 *per cent. hydrochloric [acid] and at a temperature of* 100° *Fahr.*

I.

White lead	80	66	60	50
Flint	20	34	40	46
Per-centage of free lead	24·01	19·47	12·95	14·

II.

White lead	80	66	60
Stone	20	34	40
Per-centage of free lead	23·55	15·02	12·

This problem of proportions would ap[pear] simple enough were it not that some of t[he] more complex mixtures produce frits, w[hich] are either soluble or are liable to disinteg[rate] on exposure.

The addition of borax in any large pro[por]tion is especially to be avoided when frit[ting] lead; and it is definitely ascertained tha[t if] the per-centage of boracic acid and lead o[xide] amounts to 40 per cent. the frit is noxious.

The combination of such frits can be be[tter] controlled by the preparation of alkaline [and] lead frits separately, thus checking the [ten]dency to form unstable compounds. [The] addition of alumina also assists in obvia[tin]g these difficulties, though it increased the [diffi]culty of fusion. It is, however, clear f[rom] what has been stated, that unless combine[d in] definite proportions, the fritting of lead i[s no] safeguard. Experience has already shown [that] many lead frits are noxious. Professor La[ngbe] has shown, as a result of his investigat[ion], that silicate of lead was soluble under [the] usual test to the extent of 12 per cent.; [and] the inquiry recently completed by Profe[ssor] Thorpe, when issued, will no doubt afford [the] potter full information on this important po[int].

Another important point to be decided is [the] minimum of lead possible to retain with [suc]cess. In this connection I am pleased to be [able] to produce specimens of Messrs. Copelan[d's] china, the glaze for which contains only 9 [per] cent. of lead, the quality of the ware be[ing] entirely satisfactory.

; well to note that in comparison with ther material, equal increments of heat far greater effect on lead as regards y, and this property insures that smooth- f texture and extreme brilliancy of glaze, is, so far, conspicuously absent in most ss glazes.

ıpp has shown that those glazes which ;s the highest degree of lustre and :st power of refraction, are those which t the highest specific gravity. But it is portant point that the exclusion of lead glazes removes from the list the only ial capable of imparting the needful y. We can, therefore, hardly expect to equal brilliance in glazes, so essentially in refractive power.

loubtedly, we possess in baryta one le exception, and in glass-making fairly success is attained with it, as will be seen example here shown. It is, however, a on whether this material is sufficiently uous to be admitted as an available sub- :.

d has also the important quality of ing devitrifaction, thus ensuring stable s. The tendency of many alkaline glazes come reconstituted on exposure to damp well known, and the elimination of lead ves one of the most efficient antidotes.

have in most leadless glazes three tionable properties, viz., opalinity, slug- usibility, and inequality of texture.

defects of *opacity* and *opalinity* cause rejection of many otherwise suitable llæ. Such examples of leadless frits are n here, as well as a comparison of lead leadless glaze on red body fired together. e endeavoured to deduce from the struc- of some of these the actual causes of their nity. From examination under the micro- by polarised light this defect seems in ay due to semi-opacity, or suspension of ne particles in a transparent matrix. It parently caused rather by a want of com- uniformity in the construction of the mass, n is in reality made up of two or more rate elements of differing refractive rs, distinctly non-crystalline, and in no opaque. On the other hand, the opaque, ess frit here shown exhibits altogether rent construction, being merely trans- t and not of uniform texture.

e fault of *sluggish fusiblity* is also a us objection. It leaves the slightest in- lity of thickness still apparent after firing. small scratch on the unfired piece also remaining unchanged—instead of "healing" in the oven, as with lead glaze. The mending of such fault on the raw glaze by pencilling, is impossible for the same reason.

The production of combination least liable to this defect, is one of the most important problems connected with it. The absence of lead appears to have two effects. It causes the glaze to be more viscid, but it also makes it slower in its response to the fusing temperature, as well as to the accession of heat.

To demonstrate this, I have had prepared by the very kind assistance of Mr. William Burton, a series of examples showing the behaviour of both types of glaze under precisely the same conditions. A comparison is given of the effect of firing rapidly up to Cone 01-1 (*i.e.*, hard-glost heat) in six hours, demonstrating very clearly the greater tractability of lead glaze under quick firing.

For this reason, as well as many others, glazes without lead must be dipped as thinly as possible, besides being used at a lower "slop" weight than lead, and much more uniformity of dipping is necessary.

The defect of surface inequality gives rise in some glazes to an egg-shell or pitted texture, which deprives the ware of the smoothness so essential to cleanliness, at the same time causing it to lack that brilliance now demanded by the public. It is of course too early to say that these difficulties cannot be overcome, but much attention and experience are still needed to accomplish this.

We have next to consider the possible substitutes for lead, and in doing so we are compelled to exclude those which are too expensive or scarce, those which are too low in colour, and, lastly, those which are noxious.

Of the rest the list at present is limited to the alkalies and borax, the alkaline earths, and boracic acid. Taking these in order, we find in *soda and potash* danger of disintegration, destructive influence on colours, and tendency to crazing, to be the chief defects which limit their use in any large proportion.

Of the *alkaline earths* we have lime, magnesia, and baryta. The former can only be used in small proportions. If the maximum exceeds one-eighth opalinity ensues.

Magnesia is insufficiently fusible, and hitherto no very satisfactory glazes have been produced with it.

Barytes has received the careful attention of that able chemist Dr. H. Seger, who has undoubtedly produced many successful glazes from it. They are, however, subject to the

same drawbacks as to texture and do not yield a sufficiently glossy surface.

Boracic acid, though imparting hardness and brilliancy to glaze, has injurious influence on some colours. Its use is therefore limited; but, in conjunction with silica, in carefully adjusted proportions, it has produced some of the best glazes at present discovered.

In considering the possible treatments in composition it is necessary to decide the glost temperature. Naturally the practical potter prefers to keep this as before. But the want of fluidity already noticed suggests an increase of heat in the glost oven as desirable. Dr. Seger pointed out that for lead-free glazes heat should exceed 1,050° C. But, as a rule, the earthenware biscuit is only slightly above this, and serious loss would result unless the body were changed.

Another expedient for assisting fluidity is the increase of the number of basic oxides, and this is certainly practicable. That it is, however, not absolutely necessary is shown by the formula of a successful glaze, in which it will be noted that there are only two bases:—

$$\left.\begin{matrix}\cdot 325 & K_2O \\ 75 & Na_2O\end{matrix}\right\} \begin{matrix}Al_2O_3 \\ 1\cdot 284\end{matrix} \left\{\begin{matrix}SiO_2 & 9\cdot 200 \\ B_2O_3 & 1\cdot 262\end{matrix}\right.$$

The examples shown are certainly good.

The appropriateness of including baryta as a substitute for lead is rather doubtful. It is difficult to trace any directly harmful effects to its use, and it has been distinctly stated by those constantly working with baryta that no evil result has ensued. Such glazes have been largely used, to my personal knowledge, for many years without the slightest ill effect on the workers. On the other hand, the distinct opinion is expressed by medical experts that it has several of the properties of lead, and, being a poisonous metal, it cannot be considered very safe. Notwithstanding this, Dr. Seger has proposed the substitution of barium glazes containing boracic acid for those of lead, of which the following are examples:—

No. I.

Frit.		*Mill.*	
Heavy spar	125·3	Frit	292·5
Calcined soda...	13·25	Zettlitz clay..	25·9
Crystal borax..	143·2	Sand.....	18·0
Sand......	126·0	$BaO,NaO\ 4\cdot 5SiO_2\cdot 1.5BO_3 (3:1)$	
Charcoal..	15·0		

This fuses about midway between silver and gold heat.

No. II.

Frit.		*Mill.*	
Heavy spar	125·3	Frit	297·5
Crystal borax	191·1	Zettlitz clay..	25·9
Sand	111·2	Sand....	3·0
Charcoal ..	15·0		
		$BaO,NaO,4SO_2.2B($	

This type of glaze is said to have been [suc]cessfully worked in some German pott[eries,] though there is no instance of its adopt[ion in] this country.

In America, Mr. Karl Langenbeck[, of] Zanesville, Ohio, who has given some a[tten]tion to the matter, states that he has [made] glazes from Dr. Seger's formulæ, and p[racti]cally applied them with complete success [on a] manufacturing scale, comparing favou[rably] with lead glaze in regard to cost. O[wing,] however, to their egg-shell texture an[d the] absence of the brilliant glaze required on [ware,] their introduction did not satisfy public [taste.] As regards their effect upon colours the b[arium] glazes suitable for earthenware showed t[o] advantage. But in the case of soft glaz[es for] quick muffle-firing of the type of the se[cond] formula here quoted the brilliancy of co[lours] was even greater than those made with le[ad.]

As an additional example of these gla[zes I] quote the following which has been prove[d by] Mr. Charles Binns, of Trenton:—

$$\left.\begin{matrix}CaO\ 0\cdot 35 \\ K_2O\ 0\cdot 20 \\ Na_2O\ 0\cdot 25\end{matrix}\right\} Al_2O_3\ 0\cdot 2 \left\{\begin{matrix}SiO_2\ 3\cdot 0 \\ B_2O_3\ 0\cdot 5\end{matrix}\right.$$

Besides the barium glazes above-name[d it] is also possible to produce leadless g[lazes] having lime and alkalies for the bases, a[nd in] this direction also Dr. Seger made cons[ider]able research.

His experiments go to prove that [the] formula—

$$\left.\begin{matrix}K_2O & 0\cdot 6 \\ CaO & 0\cdot 4\end{matrix}\right\} \left\{\begin{matrix}SiO_2 & 2\cdot 5 \\ B_2O_3 & 0\cdot 5\end{matrix}\right.$$

gives a glaze fusing at silver heat, and slightly above gold heat. Also that [the] following formed a glaze of general utility

$$\left.\begin{matrix}K_2O & 0\cdot 6 \\ CaO & 0\cdot 4\end{matrix}\right\} Al_2O_3\ \ 0\cdot 8 \left\{\begin{matrix}SiO_2 & 5\cdot 0 \\ B_2O_4 & 1\cdot 0\end{matrix}\right.$$

the possible limits being

$$\left.\begin{matrix}K_2O & 0\cdot 2 \\ CaO & 0\cdot 8\end{matrix}\right\} Al_2O_3\ \ 0\cdot 6 \left\{\begin{matrix}SiO_2 & 5\cdot 0 \\ B_2O_3 & 1\cdot 0\end{matrix}\right.$$

$$\left.\begin{matrix}K_2O & 0\cdot 3 \\ CaO & 0\cdot 7\end{matrix}\right\} Al_2O_3\ \ 0\cdot 5 \left\{\begin{matrix}SiO_2 & 4\cdot 0 \\ B_2O_3 & 0\cdot 5\end{matrix}\right.$$

gives a clear glaze, but the boracic acid, w

ed, causes opalinity, and this quantity on again doubled, produces a milk-white

th regard to the proportion of bases, the is—

0·2 }
0·8 } as more lime causes opalesence in all cases.

question of permanence and stability of azes without lead is one of no small imnce. Owing to the large place occupied e alkalies as fusible basic substitutes for it is easily possible to obtain combinawhich would prove disastrous in this ct, for whereas lead has proved a reliable rt to stability, the alkalies are notoriously herous. I am able, however, to show you which has been exposed for nearly 12 hs which shows no change. I understand Messrs. Mintons also have for considertime tested their new ware under trying ges of temperature and climate, so far complete success.

ubtless little opportunity has occurred to ughly prove the latest mixtures. All that be said is that they have at present stood most severe exposure and the roughest e without injury. It may, however, be y stated that with the exercise of due igence in compounding a formula no us risk need be incurred. The scientific available are amply sufficient to protect potter if he will. But if he still persists in ling ingredients in haphazard proportion out regard to the unalterable laws of nical combination, he can only expect haprd results.

face of the important problems at issue, eed to recognise that pottery manufacture *science* as well as an *art*, and that it is ect to laws as definite as those which rn the use of electricity, light, or heat.

ore than a century has elapsed since the attempt was seriously made to eliminate from pottery. The use of leadless glazes been fitful and exceptional. Up to the ent it cannot be said that for the bulk of rade they have proved practicable. Within last five years every Staffordshire potter ounced their adoption impossible. Since time such advance has been made that e, at least, of the most strenuous oppos have confessed that their views are ified, and that for many classes of ware is no longer a necessity. Some go so far o think that, with increased experience, less glazes may become available for ly all kinds of goods.

I am inclined to believe that such a result is only a matter of time. Having become fully cognisant of the limitations and difficulties attending their use, the potter will, no doubt, bestow renewed energy upon the task of bringing their treatment under his complete control. Herein, most emphatically, lies the opportunity for the craftsman of the future. Conquest of the technique rather than the initiation of new processes, must occupy his skill. Scientific economies rather than empirical discoveries will, undoubtedly, mark the progress of the coming century; and that progress must be along the line of a more accurate knowledge of the operations of great principles already laid down, rather than in the search after new ones.

I have myself entered with diffidence upon this unexplored region of ceramics, hoping to call the attention of those better qualified to the opportunity for further research, believing that no better employment can be found for scientific investigation than the beneficent task of mitigating the suffering of mankind.

It only remains for me to acknowledge my great indebtedness to those who have so kindly afforded me the benefit of their personal experience in regard to the glazes in question, and to those manufacturers who have been good enough to contribute specimens to illustrate the paper. Among these, in addition to those already mentioned, I wish to include Mr. Frank Litchfield, Messrs. Julius Hulsen, of Newcastle-on-Tyne, Mr. Karl Langenbeck, of Zanesville (O.), and Mr. Charles Binns, of Trenton (N.J.), who have afforded important help in various ways.

DISCUSSION.

The CHAIRMAN said the question dealt with in this important paper divided itself practically into two heads; the specific question relating to the manufacture of these articles, and the general question of its relation to the health of the public and the workpeople. He was not able to discuss it from the mercantile point of view, but from the scientific point of view, he thought the first object of the chemist should be to obtain a silicate glaze, formed from alkaline silicates and lime, which would be a perfectly hard substance. There seemed, however, to be certain technical difficulties about this, and no doubt lead had advantages from its introducing a low fusing point, and from certain optical properties which it possessed. The paper, however, showed that in very early times the ancients were able to do without lead, and also that at the present day, work-

ing with much better apparatus, we could also produce a glaze without this noxious substance. He hoped that with improved furnaces, it would be possible to introduce such glazes. There were certain points in connection with silicate glazes which were very difficult to deal with, the higher point of fusion necessary having an effect on certain colours; but the question arose whether the public had not been too greedy of late in requiring so many shades of colour. The Easterns were content with fewer and more stable colours, and the shades obtained by mixing them, and did not seek for the innumerable shades which were now used. There was also the very serious question of the expense to the manufacturer; but when it was considered that they were dealing with a poisonous substance, the question arose whether manufacturers would not have to be told, sooner or later, that some restriction on the use of a non-poisonous material must be imposed. He regretted that Dr. Thorpe was not present, as he had been making a very exhaustive inquiry into the matter, both in England and on the Continent. There seemed reason to expect, however, that with the more modern methods now available, they might hope to obtain a glaze which, if not absolutely free from lead, would have it reduced to the minimum quantity, in which case it might be retained in a fixed state as a lead silicate, and avoid the presence of free lead which was the cause of the evils complained of.

Mr. F. W. RUDLER said he must express his gratification at the very able and judicious manner in which Mr. Rix had treated the subject. Having charge of the collection of pottery in Jermyn-street, he was specially interested in this subject, and looking at the fine series of specimens which Mr. Rix had collected, it seemed to him that there were a good many which were in every way satisfactory. There were many underglaze colours which did not seem to be seriously affected by the coating of leadless glaze. Possibly the eye of an expert might not be altogether satisfied with some of the shades, but he thought with the Chairman that we could afford to dispense with some variations of tint if they could only be obtained by the use of poisonous glaze. If manufacturers would mark their wares "leadless," he thought there would be sufficient philanthropy abroad to make them popular. The same argument would apply to the point of brilliancy, as to which some little sacrifice might be made if necessary, out of regard for the health of the workpeople. He feared the substitution of barium for lead might be rather dangerous. If leadless glazes required to be fired at a higher temperature, more fuel would be required, and it must be more expensive; but surely the public would be willing to meet the manufacturers on this point. He hoped, however, that it would be possible to find glazes which did not require such high temperatures; and, considering what had been done during the last few years, they might look hopefully to the future.

Mr. J. EYRE thought the paper was rather in favour of lead glazes than otherwise; and it seemed to him that these glazes developed colours much better than the white glazes did. They had a very creamy tint, and fusing at a low temperature, they developed colours and preserved them, which would be destroyed hopelessly at a higher temperature. Yellows and pinks under the white glaze got very crude in tone, and he feared a yellow green would be destroyed. From the artistic point of view, therefore, it would be a great loss to abandon the lead glaze. Some of the things he saw before him looked nice and white and clean, but there was no tone whatever in them. If you compared any of these hard white pieces with a sample of Wedgwood Queen's Ware, the latter was infinitely superior. He should like to know if the people employed in glazing were more subject to disease than painters and plumbers, who worked in lead. He had not the slightest doubt that the workers brought a great deal of this trouble on themselves from their own carelessness. He had seen dippers who had been working in glaze all day, with their hands covered with it, and their clothes saturated with it also, begin eating their food without even washing their hands. A great deal of the evil might be prevented if better conditions were insisted on. Fritting would reduce the poisonous action to a very great extent, but to abandon lead altogether would be to sacrifice a great deal artistically. None of the specimens he saw around him seemed to recommend themselves from the artistic point of view.

Mr. G. G. MACWILLIAM said Mr. Rix was to be thanked for ventilating this subject. He seemed rather to favour leadless glazes, and he might say he had seen some plates made by one of the firms he had named which were very beautiful. Though they had an earthenware body the appearance was like that of porcelain; but they had only been made three months, and had not been out of England. It was a well-known fact that the severest test to which earthenware could be put was to send it to the South Sea Islands or the West Indies, where it was greatly exposed to the sea air, and under such conditions it not unfrequently crazed. Until this system had had a year or two's experience in various parts of the world no manufacturer would be justified in making it largely and sending it out as a commercial article. It would be quite useless to mark the ware as "leadless," the public would not care a pin about that; but the question of not using such delicate colours as had been in use of late years was well worth consideration. If stronger and less volatile colours were used, and leadless glaze was found to stand, they

have some other shades which would stand a temperature. It had been said that there must [be m]ay more cases of disease and death than were [reported], and, no doubt, many cases had occurred [which] were not reported in the papers; but, on the [other h]and, he could say, from personal knowledge, [that m]any cases had been attributed to lead which [had no]thing at all to do with it. Persons had been [said to] suffer from lead poisoning, and had even been [treated] for it by doctors, when it had been ulti[mately] shown that they had never been near the [lead a]t all. The greater part of the disease had [arisen] from the fault of the people themselves. [He k]new of a place where hot and cold water, [soap] and towels were provided, and a certain [amoun]t of supervision exercised, and yet the people [did no]t make use of them. In that particular case [it did] not so much matter, because the lead was [fritted]; and he believed if the lead were always [thorou]ghly fritted, and a certain amount of care exer[cised,] very few cases indeed of lead poisoning would [occur,] and those would be comparatively mild. Very [large i]nterests were concerned, and if public pressure [were b]rought to bear too strongly, without sufficient [care, s]o as to cause a revolution in the manufacture [before] sufficient knowledge had been obtained, it [would] be a very serious matter. He hoped, therefore, [there] would be no drastic legislation until the pro[posed] alterations had had a fair trial.

[Mr.] H. GRAHAM HARRIS said he did not know much [about] the manufacture of earthenware and porcelain, [but h]e did know about the making of glass of all kinds, [and t]herefore knew something about glaze. He had [always] wanted to know, and should be glad if Mr. Rix [would] tell him, what was the glaze used by the [Japa]nese and Chinese on those beautiful pots in [which] the colours were as delicate as they could [possi]bly be, and yet as intense as they could be. Was [it a l]ead glaze or a silica glaze, or was it a glaze which [no on]e knew anything about? If they could make it, [we ou]ght to be able to make it. It seemed to him [that t]he essence of the whole paper was contained in [one o]r two particulars where Mr. Rix said that if the [Gove]rnment regulations were properly carried out, [and s]ufficient supervision exercised, the results were [after] all very slight. The use of lead glaze gave the [potte]r, at a low cost, and with all sorts of latitude as [regar]ds temperature, dipping, and the place in the [furna]ce, a very much better result than he could obtain [other]wise. If that were so, could they blame the potter [for st]icking to that which he knew, which he could [deal] with easily, and out of which he could mahe a [certa]in profit. All they could do, was to put upon [him s]uch restrictions and regulations as would ensure [his d]oing his best for his employés, and then if they [did n]ot look after themselves, it was they who should [be bl]amed, and not the potter himself.

[Mr]. RIX, in reply, said there was no doubt that a [certa]in softness was given to the colours by the use of lead; and most of the wares prepared with leadless glaze showed a hardness of result, irrespective of colour, which came from want of fluidity; there was an absolute definition of the design under the glaze which was much stronger, and artistically more unpleasant than was the case with lead glazes. The same thing held good with regard to the old Persian ware. As a rule, the lead glazes as used, were softer, but that was not absolutely necessary; lead glazes could be made as light and clear as the leadless glaze. As to the indifference and carelessness of workpeople, he had purposely avoided going into that question. These people were many of them uneducated and undisciplined, and no one could exaggerate the extreme want of common-sense, amounting to absolute recklessness, of those concerned about this matter. At the same time they had long since come to the conclusion that these people should be protected against themselves, and he did not think that aspect of it had much bearing on the question. The question was were the workers injured by the lead glaze, and how far could that result be prevented? There was no doubt that further experience was needed, but the question of crazing was one of chemical expert pottery. It was not necessary that ware should craze at all, if it were correctly compounded in the first instance. Unfortunately, the manufacturer did not and could not entirely control his manufacture scientifically, and, consequently, they had to go through these proofs, and it was no use to cut the matter short. Manufacturers had been absolutely ruined by their ware crazing after it had left their hands, because it was a standing witness against them, and they could not stop the discredit which attached to it. It was necessary, therefore, to act with the greatest caution, and he fully agreed that no one should recklessly introduce leadless wares. With regard to Mr. Harris's question, there was no doubt the glazes he referred to were leadless, and were made of felspathic materials, very often of materials which needed no compounding. There were one or two favoured places in the world where the glazes were to hand ready made. One was near Limoges, where you go and dig out of the ground a beautiful glaze, grind it up, dip the ware in it, and produce a better effect than by any mixture you could make; hard, clear, and in all respects suitable. A good deal of the old Chinese and Japanese porcelain seemed to be of that character; but there were two things which distinguished that class of ware from that with which he had been dealing; they were vitreous in body, but not earthenware, which was fired at a much lower heat, so that the glazes referred to would not fuse at the heat at which the earthenware glost fires were used. They would undoubtedly do so on the American hard, semi-porcelain wares, but not on English earthenware. The pottery industry had been built up through many ages, and its present position was the result of adding continually to the experiences of many years. Obviously, therefore, they

could not expect to arrive at finality in six or twelve months.

The CHAIRMAN then moved a vote of thanks to Mr. Rix, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

AMERICAN FIBRE PLANTS.

Mr. G. E. Walsh, writing in the *Scientific American*, says:—Commercially there are 30 or 40 species of fibre plants found throughout the world, but botanically there are over 1,000 species the fibre of which can be made more or less useful in the arts and industries.

In view of the territorial changes produced by the war, the fibre industry is of peculiar interest to the farming and manufacturing world. The islands affected by the war are all noted for the fibre plants raised on them; and taken together—that is, Porto Rico, Cuba, and the Philippines—they produce a large bulk of the best plants, except cotton, used in a commercial and manufacturing way for their fibre. Manilla hemp has long been familiar wherever civilitation exists; sisal hemp comes from Cuba, in times of peace, as largely as from Yucatan or the Bahamas; Cuba bast is essential to the millinery trade of the world; and Sunn hemp and cebu hemp are but trade varieties that come from the same islands.

The Philippines, in particular, are rich in fibre plants, with possibilities for development and expansion scarcely conceivable. Throughout the archipelago, it is estimated, all the fibre used in the manufacturing world could be produced at a cost that would annihilate similar industries anywhere else in the East. This is not entirely true, however, for neither cotton nor flax could ever find a foothold in the Philippines to compete with the United States. Our cotton is already seeking Eastern markets in ever increasing proportions, and great prospects are anticipated for this trade. But in turn we must secure our hemp and jute, and other fibre-material, from the lands where they best grow.

There are over thirty species of fibre plants that can be raised in this country, but most of them are unimportant in the commercial world, and most of the others thrive only very indifferently in the United States. Should we, however, extend our colonial possessions, so that in time they included Cuba and the Phillippine Islands, as well as Porto Rico, we would be the greatest fibre producing country on the globe.

At present the leading vegetable fibre that is imported into the United States, according to statistics of 1897, is sisal grass. Most of this sisal grass comes to us from Cuba, Yucatan, a[nd] t[he] Bahamas. Attempts have been made to in[tro]du[ce] its culture in Florida, and with some success; [bu]t i[ts] superior growth in its native islands, and thei[r] clo[se] proximity to the United States, will for ever p[rec]lu[de] it from becoming an important industry here.

Next to sisal grass comes Manila hemp i[n] com[mercial] importance. The imports of this am[ou]nt [to] nearly $4,000,000 annually. This hemp has als[o] bee[n] experimented with in this country, and in other [la]nd[s], but the world's trade will always look for it[s] supply to the islands of the East, where it flo[uri]sh[es] as naturally as cotton does in our Southern [S]tat[es]. It can be produced and shipped to this c[ou]nt[ry] cheaper than our farmers can raise it at home. [Ce]bu hemp comes from the Philippine Islands also, [an]d [is] merely a trade variety that has its useful pur[pose] [in] the manufactures.

Jute and "jute butts" stand third on th[e] [lis]t [of] imported fibre plants. Jute comes from a va[riet]y [of] countries. Originally India controlled the tr[ade] [in] jute, but the West Indies and Cuba have ente[red] t[he] market in competition with her, and they ar[e] ... rivals that cannot be ignored. The possibil[itie]s [of] Cuba in this line are only partly appreciat[ed], ... rebellions and wars have so long agitated the [is]lan[d] that little experiment has been made in an[y] ... outside of sugar and tobacco-growing.

Since 1890 the Department of Agriculture ha[s] be[en] engaged in making experiments with fibre pl[ant]s [in] various parts of the country, and farmers hav[e] be[en] encouraged to grow certain fibre plants for ma[nu]fac[turing] purposes. Nearly all the commercia[l] ... plants have been tested by the Department e... and some of them have been recommended for ... culture. This movement, started seven or eigh[t] [y]ea[rs] ago, has not exactly proved all that the inaug[ura]t[ors] of it anticipated. Ramie has been raised to so[me] ex[tent] in Florida; sisal hemp from Yucatan ha[s] be[en] established in a limited way in parts of th[at] State, and a little impetus has been given to [the] [re]juvenation of flax culture—one of the oldest a[gri]c[ul]tural products in this country. Great effort[s] ha[ve] also been made to utilise some of the plan[ts] th[at] grow naturally here for fibre manufacturing. ... the palmetto fibre and vegetable hair of the S[pa]n[ish] moss growing on the trees of the Southern ... have found some use that makes the product ... value. Several of the leading varieties of ... in Florida have been cultivated for the fibre i[n] th[eir] stalks and leaves, and the palmettoes hav[e] be[en] utilised for making brushes and brooms. Jute c[ul]t[ure] has been extended, so that we produce annu[all]y [a] fair crop. Yet this weed is natural to this c[oun]t[ry], and some varieties are the finest and best grown [in the] world.

It is possible to double the annual product[ion] [of] fibre plants in the United States, and thus in[crea]se the manufactures; but the history of many ... agricultural products hardly warrants one i[n] p[re]dicting that we can raise successfully most

ants needed in this land. The flax industry one time an important industry in New d; but it has steadily declined for half a now, because farmers could put their land to profitable use in raising other crops. No of push and energy has ever been able to his industry, although spasmodic efforts have ntly been attempted. There was plenty of the world where flax throve better than in ited States, and it could be cultivated cheaper han in this country.

wise the hemp industry in the South has been ng ever since 1870. It flourished and expanded early sixties, and just prior to the rebellion it important industry, promising in time to rank only to cotton. But sisal and Manila hemp ed in the market, and the Southern hemp could mpete with them. Our hemp lost its position manufacturing world, and sisal and manila oon used in its place. No amount of study and nent could rejuvenate the decadent industry.

ile there are undoubtedly many native fibre growing in this country that will be found use- many industries, it will be impossible to make compete with the low-priced fibres that come many of the tropical and semi-tropical islands. hall we ever be able to introduce these foreign into this country, so that their culture will successful enough to supply us with the raw al for all of our manufactures. The world will ok to the Philippines, the West Indies, Cuba, l America, and China and India for the fibre that supply material for cheap clothing, bagging, and similar products.

the islands that have been acquired from Spain, ver, we have the soil and climate to produce all bre plants that are lacking in this country. resources in this respect are so great that could soon supply the world with all the raw ial used for cheap textile goods, cordage, nets, kindred necessities. In Porto Rico alone we raise successfully a dozen of the leading fibre , while in Cuba and the Philippines there are peculiar only to those islands.

PERUVIAN FUEL.

e of the fuels competing with coal in mining tions in Peru is called "yareta" by the natives. otanical name is *Bolax glebaria*, according to cent report of the Bureau of the American blic. This is a highly resinous plant, firm and act, growing on the tops and sides of the moun- cropping out from beneath the boulders, and ding out into large mounds, some of which are ich as 20 feet across. These mounds are broken means of chisel-headed bars, and the pieces are dry for three or four months. The labour is great, and the cost of preparing it is merely nal. It must be delivered during the dry season, n continues from May to November. Being of slow growth, yareta is becoming scarcer every year, and now costs, delivered at the Amalgamation Works, about 35s. per ton. At the same time a good quality of coal costs about £7 per ton, as it has to be transported from the railways to the mines on the backs of mules or llamas. Other fuels used in Peru are turf, costing about 20s. per ton at the mines; petroleum shale costing about £4 10s., and "taquia" (llama chips) costing 6s. 6d. per ton. The petroleum shale is obtained at an altitude of 18,000 feet above sea level, near Calloma. This shale is in three beds, two feet apart, varying in thickness from ½ inch to 2 inches. The Peruvian turf is cut from a marshy ground, and is more or less decomposed root-matter of a species of stiff moss. Taquia is collected from the corals and pastures of the Indians, and its use as a fuel is increasing.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 8.—"Cornish Mines and Miners." By J. H. COLLINS, F.G.S. H. BAUERMANN, Assoc. M.Inst.C.E., F.G.S., will preside.

MARCH 15.—"Liquid Fuel." By Sir MARCUS SAMUEL. Sir EDWYN S. DAWES, K.C.M.G., will preside.

MARCH 22.—"London's Water Supply." By WALTER HUNTER, M.Inst.C.E.

Papers for meetings after Easter:—

"Coal Supplies." By T. FORSTER BROWN.

"Electric Traction." By PHILIP DAWSON.

"Telephones." By JOHN GAVEY.

"Wireless Telegraphy." By W. H. PREECE, C.B., F.R.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 9.—"Leprosy in India." By H. A. ACWORTH, C.I.E., late Government Municipal Commissioner for the City of Bombay. The EARL OF ONSLOW, G.C.M.G., Under-Secretary of State for India, will preside.

This meeting will be held at the Imperial Institute.

APRIL 27.—"Judicial Reform in Egypt." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive. The LORD CHIEF JUSTICE OF ENGLAND, G.C.M.G., will preside.

It has been found necessary to change the date of this meeting from April 13 (as formerly announced) to April 27.

MAY 11.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

MAY 25.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

MARCH 21.—"The Commercial Development of Germany." By C. ROZENRAAD, F.S.S., and Fellow of the Institute of Bankers.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MARCH 14.—The paper announced to be read by Sir WILLIAM BLAKE RICHMOND is unavoidably postponed.

APRIL 18.—"Modern Changes in Taste relating to Domestic Furniture." By GEORGE LOCK.

MAY 2.—"Maiolica." By WILLIAM BURTON.

MAY 30.—"Wrought Iron Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

LECTURE III.—MARCH 6.

Driving gears—Length of crank—Block chain—Roller chain—Chain-wheels—Bevel gear—Lloyds' cross-roller gear—Compound gears—Two-speed gears—Free-pedals—Tricycle-axle.

LECTURE IV.—MARCH 13.

Steel, rubber, and pneumatic tyres—Detachable tyres—single-tube tyres—Tubeless tyres—Valves—Inflators—Side-slip—Brakes—Saddles.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Archibald Sharp, "Cycle Construction and Design." (Lecture III.)

Sanitary Institute, Margaret-street, W., 8 p.m. Dr. Alfred Hill, "Diseases of Animals in Relation to Meat Supply."

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. E. Wynter Wagstaff, "The Shan Hill Country and the Mandalay Railway."

Imperial Institute, South Kensington, 8½ p.m. Captain H. Vere Barclay, "Northern Australia."

Surveyors, Savoy-street, W.C., 8 p.m. Mr. F. J. Smith, "The Working of the Light Railways Act, 1896."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. A. Hessell Tiltman, "Public Baths and Wash-houses."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. Beale, "The Nature of Life."

TUESDAY, MARCH 7...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "The Morphology of the Mollusca." (Lecture VIII.)

Medical and Chirurgical, 20, Hanover-square, 5 p.m. Annual Meeting.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. J. T. Milton, "Water-tube Boilers for Marine Engines." 2. Sir A. J. Dursto[n] and Mr. H. J. Oram, "Recent Trials of the Mac[hin]ery of Warships."

Pathological, 20, Hanover-square, W., 8½ p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, [W.]C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. J. E. S. Moore, "Exhibition of and Remarks on Specimens of the *Medusa* of Lake Tangan[yika]." 2. Dr. A Keith, "The Chimpanzees and their Relationship to the Gorilla." 3. Dr. [B. C.] A. Windle and Prof. F. G. Parsons, "The My[olo]gy of the Edentata."

WEDNESDAY, MARCH 8...SOCIETY OF ARTS, John-s[tre]et, Adelphi, W.C., 8 p.m. Mr. J. H. C[olli]s, "Cornish Mines and Miners."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 [p.]m. Mr. William Arthur Bond, "The Establishm[ent] of Public Abattoirs in the Metropolis in relati[on] to the prevention of Tuberculosis."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m. Annual Meeting.

Royal Society of Literature, 20, Hanover-sq[uar]e, W., 1 p.m.

National Association for the Promotion of Tech[nic]al and Secondary Education, in the Hall of [th]e Mechanical Engineers, Storey's-gate, S.W., 3 p.m. Annual Meeting. Address by the Du[ke] of Devonshire.

THURSDAY, MARCH 9...SOCIETY OF ARTS, John-s[tre]et, Adelphi, W.C., 4½ p.m. (Indian Section.) (A[t th]e Imperial Institute.) Mr. H. A. Acw[ort]h, "Leprosy in India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 [p.m.] Dr. Sykes, "Objects and Methods of Inspe[ctio]n, Nuisances, &c."

Royal Institution, Albemarle-street, W., 3 [p.m.] Mr. W. Poel, "English Playhouses in the Sixte[enth], Seventeenth, and Eighteenth Centuries." (Le[ctur]e I.)

Electrical Engineers, 25, Great George-street, S.[W.], 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MARCH 10...Royal Institution, Albemarle-street[, W.], 8 p.m. Weekly Meeting. 9 p.m. Prof. H. L. Callendar, "Measuring Extreme Temperatur[es]."

Civil Engineers, 25, Great George-street, S.[W.], 8 p.m. (Students' Meeting.) Mr. H. Lapw[ort]h, "The Construction of the Elan Aqueduct, Birm[in]gham Waterworks."

Astronomical, Burlington-house, W., 8 p.m.

Philological, University College, W.C., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlin[gto]n-house, W., 5 p.m. 1. Mr. Albert Griffiths, (*a*) [A] Study of an Apparatus for the Determinati[on of] the rate of Diffusion of Solids dissolved in Liqu[ids]. (*b*) Note on the Source of Energy in Diff[usi]v[e] Convection." 2. Mr. A. A. Campbell Swi[nton], "An Exhibition of Dr. A. Wehnelt's Electr[olyt]ic Current Interruptor for Ruhmkorff Coils."

SATURDAY, MARCH 11...Junior Engineers, Westmi[nst]e[r] Palace Hotel, 7 p.m. Reception by the Presi[dent], Sir W. H. White, and Lady White, the Chair[man], Mr. B. H. Joy, and Mrs. David Joy.

Botanic, Inner Circle, Regent's-park, N.W., 3¾ [p.m.]

Royal Institution, Albemarle-street, W., Lord [Ray]leigh, "The Mechanical Properties of Bod[ies]." (Lecture V.)

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FRIDAY, MARCH 10, 1899.

' communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 6th inst., Mr. ARCHI-LD SHARP, A.M.Inst.C.E., delivered the rd lecture of his course on "Cycle Con-uction and Design."

The lectures will be published in the *Journal* ring the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the ard of the Albert Medal for 1899 early in ay next, and they, therefore, invite members the Society to forward to the Secretary, on before the 8th of April, the names of such :n of high distinction as they may think rthy of this honour. The medal was struck reward "distinguished merit in promoting ts, Manufactures, or Commerce," and has en awarded as follows in previous years :—

n 1864, to Sir Rowland Hill, K.C.B., F.R.S., or his great services to Arts, Manufactures, and mmerce, in the creation of the penny postage, and his other reforms in the postal system of this intry, the benefits of which have, however, not :n confined to this country, but have extended over civilised world."

n 1865, to his Imperial Majesty, Napoleon III., or distinguished merit in promoting, in many ways, his personal exertions, the international progress Arts, Manufactures, and Commerce, the proofs of ich are afforded by his judicious patronage of Art, enlightened commercial policy, and especially by abolition of passports in favour of British sub-ts."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential services in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improve-

ments in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (afterwards Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (now Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry —the utilisation of waste silk."

In 1887, to HER MAJESTY THE QUEEN, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb.R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph (now Lord) Lister, F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries by which not only has the art of surgery being generally promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., "in recognition of the serviees he has rendered to Arts, Manufactures, and Commerce by his m

ica researches and the resulting development of iron and steel industries."

n 1896, to Prof. David Edward Hughes, F.R.S., recognition of the services he has rendered to s, Manufactures, and Commerce, by his numerous ntions in electricity and magnetism, especially printing telegraph and the microphone."

n 1897, to George James Symons, F.R.S., "for services he has rendered to the United Kingdom affording to engineers engaged in the water ply and the sewage of towns a trustworthy basis their work, by establishing and carrying on ing nearly forty years systematic observations w at over 3,000 stations) of the rainfall of the ish Isles, and by recording, tabulating, and phically indicating the results of these observa- is in the annual volumes published by himself."

n 1898, to Professor Robert Wilhelm Bunsen, D., For. Memb. R.S., "in recognition of his nerous and most valuable applications of Chemistry Physics to the Arts and to Manufactures."

Proceedings of the Society.

REIGN & COLONIAL SECTION.

Tuesday afternoon, February 28th, 1899; jor-General Sir OWEN TUDOR BURNE, C.I.E., K.C.S.I., in the chair.

The paper read was—

PERSIAN TRADE ROUTES.

By A. HOTZ.

At last a start has been made to provide rsia with roads. Before describing what is v being done by Russia from the North and England from the South, it may be useful give a short summary of this question, which s become a vital one for Persia ever since depreciation of silver has necessitated an reased export to restore the balance of de.[1]

Those who are best acquainted with the country have been the most persistent in pointing out the want of roads. Among the more recent papers on this subject, three of which were read in this room, may be mentioned those by General Sir Frederic Goldsmid,[2] General A. Houtum Schindler,[3] Colonel J. Bateman Champain (two),[4] Captain H. L. Wells, R.E.;[5] Drs. F. Stolze and F. C. Andreas;[6] General Sir R. Murdoch Smith (two);[7] Colonel M. S. Bell, V.C.;[8] the Hon. G. N. Curzon, M.P.,[9] and Mr. H. F. B. Lynch.[9] Besides these special papers, constant mention is made in consular reports of the absolute necessity of improved communication between the Persian Gulf and the interior; those by H.M.'s Consul at Isfahan, Mr. J. R. Preece, are particularly instructive in that respect.

If we consider the present means of conveyance, it is indeed astounding that a country of about 636,000 square miles without navigable rivers;[10] but inhabited by 9,000,000 people, of whom it is estimated that one-fourth are settled in towns and half are agriculturists, and who are remarkable for their intelligence and industry, should have to carry on its foreign trade and local traffic along mule tracks, the like of which are hardly to be met with in any other part of the world, however backward. The passes between the Gulf ports and the Persian plateau are in the same condition as Herodotus described them, and as they were found by Marco Polo and his innumerable successors. But it will not be necessary to enlarge on this subject, which has been repeatedly put before the public by those most qualified to deal with it, neither would it serve any purpose to discover the reasons why the Persian Government have not themselves provided their country with roads, or do not apparently intend to do so in the near future. We have to face the question as we find it:

1 The drain on Persia in consequence of the great difference veen her imports and exports has of recent years become serious, and has been the indirect cause of some disturb- e in her finances. People cannot now pay the taxes they l to, and the prosperity of the country is diminishing. Its urces, however, are capable of expansion. The reorgani- on of the Customs, for instance, has lately been taken in d by the Shah's Government, with the result that Persia secured the services of one of the chief inspectors of toms in Belgium, M. Naus, who has been lent by his ernment for that purpose. He is assisted by several of countrymen, all trained in the Belgian service, and he has ady, by his energy and tact, obtained most satisfactory lts. The Custom-houses, as is well known, are farmed in sia, and in some cases they now pay nearly double the unt they used to send to Teheran. But, of course, an ease in the revenues obtained by stricter collection does increase prosperity.

2 "Journal of the Society of Arts," April 27th, 1877.

3 "Zeitschr. der Gesellsch. für Erdkunde," 1877.

4 "Proceedings of the Royal Geographical Society," March, 1883, and "Journal of the Society of Arts," April 6th, 1883.

5 "Proceedings of the Royal Geographical Society," March, 1883.

6 "Peterm. Mitt. Erganzungsb," 77, 1885.

7 "London Chamber of Commerce Journal," March, 1889, and "Journal of the Society of Arts," May 10th, 1889.

8 "Blackwood's Magazine," April, June, July, 1889.

9 "Proceedings of the Royal Geographical Society," September, 1890.

10 The Karun in the south-west is only navigable for little over 200 miles (with an obstruction about midway). The rivers whose waters join the Caspian Sea become quite shallow a few miles from their mouths.

an immense country on the high road between the East and Europe totally unprovided with efficient means of carriage either by land or water.[11]

The total trade of Persia with foreign countries is estimated[12] at £3,975,984 imports, and £2,100,901 exports, and it is carried on along the following trade routes:—[13]

I.—From the South.

1. *Bushire to Shiraz, Isfahan, Teheran.*—Imports, 1897, £1,145,329. (1895, £1,016,917; 1887, £655,315.) Exports, 1897, £392,532. (1895, £528,827; 1887, £469,891.)

2. *Bender Abbas to Kerman, and viâ Yezd to Meshed and Central Asia.*—Imports, 1897, £381,562. (1895, £478,254; 1887, £349,142.) Exports, 1897, £230,781. (1895, £324,920; 1887, £292,624.)

3. *Lingah.*—The imports are mostly distributed in the neighbourhood or re-exported. Imports (omitting specie), 1897, £442,472. (1895, £429,991; 1887, £550,501.) Exports (omitting specie), 1897, £384,714. (1895, £368,739; 1887, £474,573.)

4. *Mohammerah—for Shushter, Dizful, &c.* — Imports, 1897, £121,407. (1895, £180,631; 1890,[14] £146,141.) Exports, 1897, £87,473. (1895, £91,457; 1890, £53,096.)

5. *Bagdad to Khanikin Kermanshah, Hamadan, Teheran.*—Between one-third and one-fourth of the imports are in transit for Persia; of the exports a somewhat smaller proportion comes from there. Imports from India and Europe, 1897, £1,182,645. (1891,[15] £914,886; 1887, £761,499.) Exports to Europe and America, 1897, £522,960. (1891, £564,900; 1887, £514,840.)

II.—From the North.

1. *Resht and other ports on the Caspian Sea.*—Imports from Baku, 1896,[16] £842,655 (1895, £1,152,479; 1891,[17] £806,327.) Exports to Baku, 1896, £365,342. (1895, £301,762 1891, £294,053.)

2. *Tabriz, for Azerbaijan,* and distribution east and south as far as Teheran, Meshed and Kurdistan.—Imports, 1896-7, £648,920 (1894-5, £350,339; 1886-7, £795,370.) Exports, 1896-7, £256,720. (1894-5, £162,808 1886-7, £253,023.)

3. *Meshed, for Khorassan,* trades by way of Astrabad, near the Caspian, and *viâ* Kushan, to Ashkabad on the Trans-Caspian Railway. — Imports from Russia and the Khanates,[18] 1897-8, £121,307. (1895-6, £86,929 1889-90,[19] £110,408.) Imports from Afghanistan, 1897-8, £12,178. (1895-6, £11,859; 1889 90, £17,272.) Imports *viâ* Trebizond, Tabriz Teheran, 1897-8, £26,673. (1895-6, £24,166 1889-90, £39,103.) Imports from India, *viâ* Bender-Abbas, 1897-8, £130,282. (1895-6 £199,167; 1889-90, £184,583.) Exports to Russia and the Khanates, 1897-8, £79,454 (1895-6, £67,889; 1889-90, £111,442.) Exports to Afghanistan, 1897-8, £1,149. (1895-6 £908; 1889-90, £1,143.) Exports to Afghanistan (Foreign goods in transit), 1897-8 £15,857. (1895-6, £11,760; 1889-90, £17,156. Exports to India, *viâ* Bender-Abbas, 1897-8 £40,083. (1895-6, £22,269; 1889-90, £38,958

Besides these chief trade channels, the exist some of minor importance by which good enter Persia from Turkey on the West, an from Afghanistan on the East, by Hera Meshed. A new route from which great resul are anticipated for the trade between India an Persia (and in transit to Central Asia) h been opened two years ago from Quetta, c the Indian Railway system, by Nushki, Cha Amir, Kuh Malek Siah, Nasratabad, Birjan Kain, and Turbat-i-Haideri to Meshed (1,0 miles, 53 stages).[20] The Indian Governme has caused wells to be dug on the line of mar as far as the Persian frontier. The bounda between Afghanistan and Khazan has be rectified, so that the road does not tou Afghan territory, and a line of telegraph h been projected, following the road as far Chah - Amir, there branchiug off to Lad Regan, Kerman, and Kashan, where it w join the existing Indo-European telegraph lir thus making the latter independent of t

[11] In "Persia and the Persian Question," vol. i, pp. 485-92, and vol. ii, p. 574, the Hon. Geo. N. Curzon, M.P. (now Lord Curzon of Kedleston) gives a clear *résumé* of the condition of things then existing (1890) and which has not since altered.

[12] "Almanach de Gotha," 1899.

[13] The following figures have been taken from the English Consular reports of Bushire, Resht, Bagdad, Trebizond, and Meshed. The amounts are not reliable, but approximate, as it is impossible under the present system of farming Custom taxes to collect exact statistics. Only the chief ports and Custom-houses are here mentioned, so that the total of their imports and exports does not correspond with the estimated total trade of the country. A large proportion of the imports (notably those of the Gulf ports) are re-exported to other Persian ports or to the Arab coast. The same thing will take place to a less extent at the Caspian Sea ports.

[14] First report since establishment of vice-consulate.

[15] The consular reports for 1892-5 do not give the usual statement of imports and exports.

[16] For 1897 the returns have not been published.

[17] First report since re-establishment of consulate.

[18] Partly entered at Astrabad on the Caspian.

[19] First report since establishment of consulate-general.

[20] Meshed Consular Report for 1896-7. No. 2,008.

e between Bushire and Kurrachee.[21] This e will be chiefly used for the carriage of but since the Central Asian Frontier has n virtually closed against non-Persian pro- e entering from Persia, its importance as a mercial highway will be confined to con- ption in Seistan and Khorassan.

ll these roads are what have been called atural" ones; in other words, mere mule ks.

he cart roads (more or less metalled) at sent existing in Persia are the following:— eran-Kasvin (1880), 96 miles; Teheran- n (1883), 97 miles; Meshed-Kushan-Ash- ad (1890), 150 miles, of which 30 are on ssian territory; and some short roads in immediate neighbourhood of Teheran, iefly to Royal palaces.

Concessions have been granted, or have been red from time to time, for the following ds: — Teheran (Kum)-Burujird-Shushter- was, with branch road from Burujird to han; Teheran-Tabriz-Julfa (on the Aras); heran-Kermanshah-Khanikin-Bagdad); Ta- z-Ardebil-Astara; Tabriz-Khoi-Bayazid; jan-Hamadan-Burujird; Kasvin-Resht- -i-Bazaar (with the right of purchasing existing road, Kazvin-Teheran); Kazvin- madan.

Of these roads only the last but one men- ned is in course of construction. Different cumstances have prevented the carrying out the other projects. The principal one of se was undoubtedly that from Teheran to waz, known as the "Karun Road." It is matter of great regret for the development of rsia that this important scheme has not n carried out, as it would have secured the ute which alone answers all requirements, ng the shortest and least difficult one from capital to the sea, besides opening up the y well-watered provinces of Persia.

Soon after the Lower Karun had been de- red free to all flags, and the Imperial Bank Persia had been established (1889), when a short while the country attracted the ention of the English promoting world, the e Shah Nasr-ed-Din, amongst other schemes ich were doomed to failure (tobacco regie, he monopoly, lottery, &c.) gave a concession to his Minister of Commerce—Yaya Khan, Mouchir ud Dowleh—for the construction of a road from Kum to Ahwaz, by way of Sultanabad, Burujird, Khorremabad, Dizful, Shushter, with a branch road from Chelunchuan to Isfahan. Later on, the option was granted to continue the road to Mohammerah at the confluence of the Karun and the Shat-'l Arab. This concession, which gave the right of levying tolls, was bought of the Mouchir ud Dowleh by the Imperial Bank of Persia, with the intention of forming a separate company to construct and work the road. This plan could, however, not be carried out, as the short spell of speculative prosperity had passed away. Meanwhile, capable engineers had been sent out, and much money was spent in making a survey of the whole road, and on repairing the existing section, Teheran-Kum, which had been sold to the Bank by the Emin es Sultan, who is now Sadrazem.[22] Unfortunately this work was done in such a thorough manner that it soon exhausted the amount which the Bank felt justified in advancing, whereas the prospect of ceding the concession to a separate company became more and more remote. With this latter object, however, a regular service of diligences and fourgons between Teheran and Kum was established, and carriages were let for the same journey. It was hoped that these conveniences would create a want. The attempt did not prove a success financially, and the Bank has since tried the experiment of farming the road to a Persian, but after some time it has again taken the service under its direct management, conducting it in a somewhat rougher fashion than it was started originally, and therefore more in proportion to the real requirements. (Recently authority was obtained to prolong the road by way of Kashan to Isfahan, there to meet the road from Ahwaz, through the Bakhtiari country, which will be described later on. This authority does not, however, interfere with the existing rights for the construction of a direct road from Kum to Ahwaz.)

The construction south of Kum was stopped. This result was all the more deplorable, because the concession remained with the Imperial Bank of Persia, and if the Shah's Government or some European combination should sooner or later feel inclined to under-

A land route from India to Eastern Persia was ocated by Sir Frederic Goldsmid as long ago as 1877, in a er read before the Society of Arts on the 20th of April of t year (*Journal*, No. 1275), viz., along the Mekran coast Gwadar or Kej, and thence by Bampur to Kerman. The longation of the Indian railways beyond Quetta, and the tification of the Southern frontier of Afghanistan have icated the route that has now been selected.

22 The road had been built in 1883 by this minister's father, who was also styled Emin es Sultan. The bridges were in bad repair and the road itself had not been looked after for years. The five Mehman Khanehs were extensive and well-planned.

take the work, they would have to come to terms with the Bank, which would, in the first place, endeavour to be refunded the amount (£85,000) which had been written off as spent on the easy first section, on surveys, and on the purchase of the concession; an outlay which would be altogether out of proportion to the strict cost of the whole work. There is no doubt that the project of making a self-supporting road, fit for wheeled traffic, all the way from Teheran to Ahwaz (about 530 miles), and a branch road from near Burujird to Isfahan (210 miles), was too ambitious a one. The money spent on the first section and surveys would probably have been sufficient for the complete work if the promoters had been satisfied with good mule tracks in the mountainous parts, leaving further improvements to the future.[23]

Meanwhile, Russia had been roused from her apathy with regard to public works in Persia, first by the action of those "who blew so loud and foolish a trumpet over the opening of the Karun to foreign trade in 1888,"[24] as Lord Curzon of Kedleston, says in his well-known work on Persia, and afterwards by the establishment of the Imperial Bank of Persia, and the concession of the Karun road. As a result she claimed and obtained the right to construct roads for wheeled traffic from Kazvin to Resht, with the option of buying the existing road from Kazvin to Teheran.

Of late years Russian trade has made undoubted progress in Persia. This is in no way surprising if we consider her geographical position, and the truly wonderful development that has taken place in her industry. In this, as in other respects, she is slowly but stea fulfilling her destiny.

Russian sugar reigns now supreme in north of Persia, having beaten all competit Prints from Moscow are paramount in North-West; they divide about equally Teheran market, with those from Manches and they are beginning to appear in the baza of Central Persia. At Tabriz, Manchester only been able to keep a firm hold of market because the freight from Moscow higher than that from Lancashire.[25] At time, a change in the railway freight betw Moscow and Odessa may alter the situation favour of Russian prints. In glass and ear enware, candles, petroleum, and a few ot articles of less importance, Russia is, in m cases, without opposition in North Persia. far the chief articles are, however, sugar cotton. It is well known that their success Persia has been secured by an elaborate syst of bounties. This system has been often decr in England, but Russia is a new country in economic sense, and her commercial pol should be judged in that light. Her tariff in any case created a flourishing industry, a the sugar, candles, and certain classes cotton goods which she exports to Pers generally represent the over-production of works. Their output helps to cheapen, rather to enhance the profit on what is sold the home market, and the whole system the same effect in Persia that the Continen sugar bounties have on consumers here. T trade that Russia does in Persia may be call artificial, but it is nevertheless a rapidly growi one. It is, however, confined to the nor We find clear proof of this in the consu reports. For instance, at Bushire the to imports in 1897 amounted to £1,145,329; this the United Kingdom and India contribut £974,386, Russia £750. The exports amount to £392,532, of which £172,653 went to t United Kingdom and India, and only £1 Russia. If we compare these figures with tho of the Tabriz and the Meshed reports (whi indicate a large proportion of English trade notwithstanding the fact that Russia is

[23] Unless assisted by a Government guarantee of a minimum interest, a well-built road fit for wheeled traffic all the year round can hardly be expected to earn a reasonable return on the capital laid out. At a low computation, about £200,000 would be required for such a road, so that with cost of animals, rolling stock, concession and working capital, about £250,000 would have to be invested. It has been estimated that for a roughly-metalled, fair-weather cart-road (*i e.*, fourgons when the nature of the soil and the weather permit, baggage animals when this would not be practicable), 15 feet wide, which could in many places be reduced to 10 or 12 feet, with a maximum gradient of 1 in 9, could be made for about £85,000. This would include:—The present road, Teheran-Kum, with 7 guest-houses, at purchase price plus cost of improvement, and a roughly-metalled road from Kum to Ahwaz, and branch road to Isfahan, with the necessary number of caravanserais, but with ferries, no bridges, at Dizful and Shushter. Adding to this £30,000 for concession and working capital, the total investment would amount to £115,000, that is supposing that the pack animals would be contracted for, to work for a certain sum per diem, their keep at the charge of the owners; the company undertaking the transport of goods at a tariff, and charging tolls to outsiders.

[4] "Persia," by the Hon. Geo. N. Curzon, vol. ii., p. 387.

[25] The freight from Moscow to Odessa, I was told, is high as that from Odessa to Bagdad. There exists a spec railway tariff in Russia for goods exported to the Far Ea but this tariff does not apply to the Levant or Persia.

[26] In 1895-6, Tabriz imported 9,784 bales; in 1896-7, 9, bales of cloth and grey shirtings from Manchester, and no from Russia. Of prints, Manchester sent, in 1895-6, 9, bales (in 1896-7, 9,080 bales), and Moscow 678 (in 1896 1,572 bales). For details of imports of Khorassan, see 342.

r) there seems no reason to grudge her an nsion of trade which has been obtained at h great sacrifices.

he new road from Resht to Teheran is the st move that Russia has made to widen the le of her Persian trade.

)uring a recent visit to Teheran and Russia ıd an opportunity of obtaining the following ails with regard to this undertaking.

The concession to construct this road was en in 1893, and includes the right of widen- the entrance to the Murdab at Enzeli. It granted to "The Compagnie d'Assurance de transports en Perse," founded by Mr. S. Poliakow, of Moscow, who is also the nder of the International Commercial Bank Moscow, which has a branch office at ıeran. It is said that the Russian vernment have shown a keen interest in scheme, and that it was at their request t Mr. Poliakow undertook the enterprise. At events, it was no doubt through official ssure that the chief merchants and manu- turers at Moscow who have, or are in the ure likely to have, business relations with rsia, became shareholders of the company which the concession was sold, and which s formed with a capital of 1,000,000 roubles 1,000 shares of 1,000 roubles. Some of the scow firms took as many as 100 and 150 ıres.

At first the work was taken up with much l, but possibly discouraged by the formid- e difficulties met with as soon as the higher ges of the Elburz were reached, and which essitated a larger expenditure than may ve been foreseen, this energy became ıdually less until it looked as if the plan had n abandoned. In 1897, however, Colonel zichovski, who had been given charge by company of the whole work, came to rsia on a visit of inspection, and soon after return the Russian Government decided to ne to the assistance of the company by ing debentures to the amount of 1,000,000 ıbles, on condition that the work should be ished without delay. According to the ms of the concession, the road should have n ready for traffic at the end of last year, t a prolongation of one year was obtained. ıding that the 2,000,000 roubles were not ficient to complete the road, the Government ain came to the aid of the company by ing another 500 debentures of 1,000 roubles, condition this time that the capital should increased by 700,000 roubles. This was ne (most of the shares were taken by the original shareholders), so that the company is now working with a capital of 3,200,000 roubles (1,700,000 rouble shares, and 1,500,000 rouble stock), or, say, £340,000.

This no doubt seems a large amount, but it should be borne in mind that it includes the cost of the concession, Enzeli-Kazvin, with extension to Hamadan, at £40,000 and the purchase of the Kazvin-Teheran road at the same price. The cost of the actual road-making has been 30,000 francs per kilometre, and that certainly does not seem excessive, as the difficulties have been great. Between Pir-i-Bazaar, Resht, and Kuhdum, for say twenty miles, where the soil is exceedingly marshy, large quantities of stone, brought from distant mountains, had to be used in many layers before a sound foundation could be obtained. This work went on for two years, and was much hampered by the fact that rice is cultivated in many places on both sides of the road: the complicated system of dams and dykes for irrigation purposes making the work very tedious. At first, Russian workmen were employed, but the mortality among them in the lowlands near the Caspian was very great; during the first year 30 out of 300 died of malarial fever. They have been replaced by Italians, who resist the climate better. After reaching the mountains difficulties of another, but hardly less costly nature arose. Near Rudbar, Menjil, and Mullah Ali not less than 50 miles had to be cut through solid rock by means of "roburite" imported from England.

The local management is in the hands of Captain Glinoefski, who has had much experience of road building.[27]

Starting from Pir-i-Bazaar on the Murdab, the road (6 miles) turns to the left quite near Resht, crossing the Rudbar by a wooden bridge, thus avoiding the town with its narrow streets. It then follows the old track to Kuhdum, and was practicable last spring for carriages as far as Ziah-rud, 8 farsakhs, or about 30 miles from Resht. The road now begins to climb in earnest, and it frequently leaves the old mule track. In April I found it levelled and ready for use as far as Rudbar (14 farsakhs, or about 47 miles from Resht), and I have just heard from Colonel Mszichovski

[27] Both Col. Mszichovski and Capt. Glinoefski were educated at Government colleges, and have the rank of Colonel and Captain of Engineers respectively. But they are not in Government employ, although they may be called to do service at any time. I am indebted to the first-named gentleman for much of the following information regarding the Resht road.

that it has been opened for traffic as far as Menjil, that is half the distance between Enzeli and Kazvin.

From Rudbar to Menjil and Paichenar several gangs of seemingly over a hundred men each were at work, blasting and pickaxing the solid rocks of limestone which line the Sefid Rud so impressively.[28] All travellers to Teheran will remember the approach to the Menjil bridge coming from Resht, and will realise the enormous expenditure of work that was required to cut a road with a practicable gradient through these forbidding masses. Here the old road, a veritable rock ladder, on which the unfortunate mules or chapar horses have to clatter as best they can, has been of no use whatever to the new one. Under these circumstances, it was necessary to limit the width to the narrowest possible dimensions. At such places the road is 5 metres ($16\frac{1}{2}$ feet) broad, but at distances of 200 metres it has a wider stretch, so as to allow for the passage of two carriages. The normal width between Resht and Teheran will be 3 saschens (21 feet), the usual gradient is 1 in 24 to 1 in 20, in a few exceptional cases 1 in 15.

Nothing has been done, so far, to the bridge at Menjil, of which, as usual of late years, a couple of arches have fallen in. Caravans have at present to pass with great precaution by a very ricketty construction of wooden rafters, supported by and attached to the pillars of the bridge. Carriages could not possibly use this quaint structure, which is very narrow, and about 142 yards long. As it is cheaper in Persia to build a new bridge than to repair an old one, it has been decided to replace the present structure by one of iron. The material has arrived from Russia, but as the Sefid Rud is a stream with a considerable current, the work of spanning it will take time, and it will be no doubt necessary, for some months after the

[28] The following details about the staff and workmen employed may be of interest. Besides the chief engineer, M. Glinoefski, there are, in Persia, 2 engineers, and 12 assistant engineers, or chiefs of sections (this number has been gradually reduced as the work advanced.) Further, a chief bookkeeper with 2 clerks, and 5 or 6 juniors. Also a doctor and several assistants. The number of workmen was, at first, about 4,000 (1,000 horses and donkeys for the transport of gravel), but at present there remain only a few hundred in the few sections that have not been completed. They are chiefly Persians and Kurds, and a small number of Greeks, Turks, and Italians. There are few Russians employed now, for reasons already explained. On the whole, nearly a million cubic metres have been dealt with, of which about one-third, in rocky parts, was where the European workmen were chiefly engaged, because the Persians of the Caspian provinces are deficient in energy and strength, on account of the climate.

completion of the road, to change carriage at the bridge, crossing it on foot with the hors[29]

At Paichenar a young engineer, M. Wol-seider, has his headquarters. So far, the road has followed on the tracks of the old except for a few short deviations. But i now approaching the Kharzan Pass (ab 7,500 feet), a conclusive barrier to anything wheels. The two roads here part compa and the new one, following the telegraph as far as Kuhin, makes a detour of about miles by following the left bank of the Y bashi river, and, passing by Mullah-Ali, wh another iron bridge will be built, rejoins the road at Agha-Baba.[30] I have not visited part of the road. Last spring, work there not been commenced. It is now well on way. General Schindler is, as far as I kn the only traveller who has described this

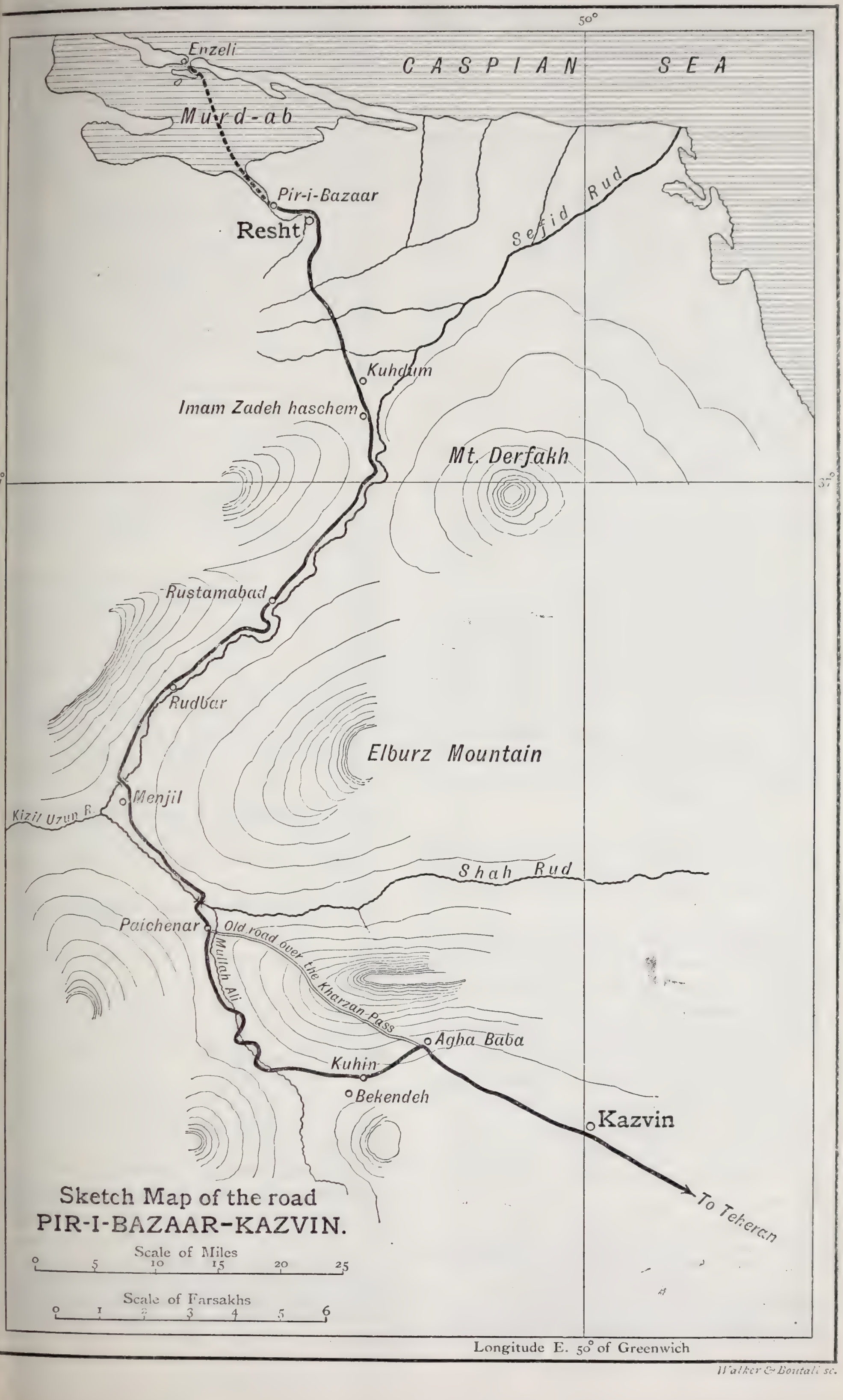
[29] The same plan is followed on the road from Tifli Vladikavkaz whenever snowdrifts block the passage. was the case last winter between Goudaour and Kob about a verst. Arrays of vehicles of all descriptions, f the humble tarantass to the lumbering diligence, were fo ready on both sides of the obstruction waiting for arrivals.

[30] It may seem strange that a busy traffic, such as e between Teheran (and Kazvin) and Resht, has been suff for many years to pass by mountain defiles which, in win are often blocked by snow for weeks, and which lev annual toll on men and animals perishing from cold. may be asked why the detour by Moullah Ali was not covered and made available for caravans long ago. same thing, however, occurs in Persia in many places.

The stages of the post road between Resht and Teh are at present as follows:—

	Farsakhs.
Resht-Kuhdum	6
Kuhdum-Rustumabad	5
Rustumabad-Menjil	5
Menjil-Paichenar	4
Paichenar-Kharzan	4
Kharzan-Agha-Baba	4
Agha-Baba-Kazvin	4
	32 Farsak
or say 112 miles.	

Formerly the section Paichenar-Kazvin was divided in stations: Paichenar-Mezreh and Mezreh-Kazvin, both about the same distance (5 farsakhs). With the exceptio the last $4\frac{1}{2}$ farsakhs, nearest Kazvin, the road passes such difficult ground that it was decided a few years ago establish two post-houses: Kharzan and Agha-Baba, an close Mezreh. Although the road still passes by the l place and follows in every detail the old track, the for distance of 10 farsakhs has apparently grown into 12; the explanation is that fractions of farsakhs are calculate entire ones for the hire of horses, which are charged distance: at present $1\frac{1}{2}$ kran per farsakh. It used to be 1 in 1892, and $\frac{3}{4}$ kran some 15 years ago. The fall in silver reduced the power of the kran. At Kharzan and Agha-B no post-houses have been built; travellers are accommod in caravanserais, the one on the Kharzan being ruined, of the most primitive description. The advent of "Russian road" round the Kharzan has put a stop to progress that may have been contemplated.


50°
CASPIAN SEA
Enzeli
Murd-ab
Pir-i-Bazaar
Resht
Sefid Rud
Kuhdum
Imam Zadeh haschem
Mt. Derfakh
37°
Rustamabad
Rudbar
Elburz Mountain
Menjil
Kizil Uzun R.
Shah Rud
Paichenar
Old road over the Kharzan Pass
Mullah Ali
Agha Baba
Kuhin
Bekendeh
Kazvin
To Teheran
Sketch Map of the road
PIR-I-BAZAAR-KAZVIN.
Scale of Miles
0 5 10 15 20 25
Scale of Farsakhs
0 1 2 3 4 5 6
Longitude E. 50° of Greenwich
Walker & Boutall sc.

tion,[31] and his itinerary is the same as that adopted by the Russian company. The following is a brief summary:—

"Leaving Teheran (in July, 1879, just before the construction of the present Kazvin road) Agha Baba is reached by a good road of 14 miles. Continuing almost due west, the Bascher is crossed (2 miles) and passing Bumehin a descent to the Do-deh plain, followed by an easy ridge, leads to the large village of Kuhin (5,106 feet) situated in a fertile valley (5 miles from Agha Baba). Nearing the Azalek, a small stream, by a somewhat sharp climb, the Aspabin plain is reached, dominated by the Piruz. The direction has now become north-west, and at Beg Baghi (3,056 feet) changes to north, when the road traverses the broader watershed of the Yuz-bashi,[32] where, as a sign of a milder climate, figs and oleanders are observed. Following the windings of this valley the winter settlements of the Ghaswend nomads are passed. The road now enters the valley of Mullah Ali (also called Hassan Khani) with the finely-situated village of that name, which is deserted in summer. Here a bridge is required during the spring floods. A couple of miles further, passing the village of Kogir, the post-house of Paichenar is reached (1½ miles beyond Paichenar the Yuz Bashi joins the Shah rud, which at Menjil unites with the Kizil uzun, forming together the Sefid Rud). In a footnote the general character of the road is described as offering much less difficulty than the one crossing the Kharzan pass. The undulations are more practicable, the winters are milder and more free from snow. Many villages are met with. Incidentally the road is mentioned as being the one chosen for the then (1879) projected railway from Resht to Teheran."

Between Paichenar and Kazvin two new post-houses will be built, on the other sections the existing stations will be put in thorough repair.

At Agha-Baba the gradually rising plain is entered that stretches to Kazvin and Teheran, and there are now no more engineering difficulties to contend with; in fact, a rough cart road has been in use for some time as far as Kazvin, and all that has to be done is to metal it and provide for drainage. From Kazvin to Teheran a regular carriage service has been in existence for about 18 years. It is at present farmed by a Persian, who keeps the service in a fairly efficient state. The distance of 96 miles, divided into six stages of equ[al] length, is covered in 16 hours under avera[ge] circumstances. After a heavy snowfall the[re] is delay. The road has an excessive widt[h] and is not metalled. The bridges are in b[ad] repair and unsafe. The Russian compa[ny] will have to spend a considerable amount [of] money to bring this road up to the level [of] what is being done beyond Kazvin; but thi[s,] in good time, will be accomplished.

The company does not intend for the prese[nt] to undertake the carriage of passengers, mail and merchandise, although it has acquired t[he] right to do so. The revenues of the road wi[ll,] therefore, have to be derived entirely from t[he] tolls. These have been fixed at 4 krans (s[ay] 1s. 6d.) per pack animal (horse, mule, donke[y] or camel), from Resht to Kazvin, and t[he] same from Kazvin to Teheran. Carriages p[ay] 42 krans (17s.) for four horses, 30 krans (12s[.]) for three, 20 krans (8s.) for two, and 10 kra[ns] (4s.) for one. Loaded carts pay 50 krans (20s[.]) each. A proportionate deduction is made f[or] a shorter distance.

People at Teheran are waiting impatient[ly] for the completion of the road, and no dou[bt] much polite pressure is being exercised, not t[he] least by the different legations. In fact, t[he] chiefs of the two principal ones have ha[d] personal experience of the hardships of t[he] old order of things. Both Sir Mortim[er] Durand and M. Argiropulo have been detain[ed] for days in very uncomfortable huts near t[he] Kharzan waiting till a path had been ma[de] through the snow. The sufferings of the gre[at] often bear good results for the multitud[e.] Foreign ministers travel too seldom on oth[er] roads in Persia.[33]

M. Mszichovski is very sanguine that t[he] entire road will be finished by the end of Ma[y,] and it will be opened with some ceremony [in] the presence of the Sadrazem and the Russia[n] Minister at Teheran, who have been invited b[y] the company to visit Resht for that purpos[e.] Should there be unforeseen delay, the inaugura[tion] will probably be postponed until t[he] autumn, because the weather in Persia betwe[en] May and September is too hot for such [a] prolonged picnic.

Supposing the road to be ready, which wi[ll] certainly be the case, in August or Septemb[er] this year, the question remains how to impro[ve]

[31] "Zeitsch. der Ges. fur Erkunde," Berlin, vol. xiv. p. 119. The paper is accompanied by a map, Resht-Teheran scale 1 : 600,000, published and annotated by H. Kiepert.

[32] Near here, at the site of a ruined Shah Abbas caravanserai, the extension to Hamadan has been planned to start. This, however, will not be taken in hand before the Resht-Teheran road has commenced to pay good dividends.

[33] Last November M. Mszichovski came all the way fro[m] Teheran to Resht by carriage, with the exception of about [ ] miles between Paichenar and Mullah Ali, for which he had [to] use the saddle. No doubt he was able to arrange speci[al] facilities.

existing primitive state of things between -i-Bazaar and the Caspian. Ultimately, no ubt, the road will be prolonged to Enzeli, t this, it is estimated, will cost from £80,000 £100,000, the ground being very marshy, d a long detour round the Murd-ab will have be made. For the present it is intended to content with a service of lighters and tugs ross the ten miles' broad lagoon. For an interrupted communication between Enzeli d the sea, it will be necessary to deepen and den the channel that unites the waters of the urd-ab and the Caspian so that steamers n enter the lake which itself is of sufficient pth.[34] The concession to Mr. Poliakow ovides for this option. I was told the best ace for a port seems to be to the south-east the present town of Enzeli.

Resht has grown rather prosperous of late ars. The silk industry, which had suffered eatly through a disease of the silkworm, has en revived by the introduction of seed from ance and Italy. The fisheries on the Caspian e flourishing, and altogether the place gives impression of welfare compared to other wns in Persia. The Governor, H. E. Sat Saltaneh, is spoken of as an enlightened, ergetic man.

The journey from Western Europe to eheran will be greatly facilitated and ortened by the new road. From London to esht 12 to 13 days are at present required—at is if no delays are encountered, viz. :

London to Batum, *viâ* Berlin.	Days.
arsaw and Odessa	7
elay at Batum ½ day, Batoum to Baku 1½ days	2
aku to Enzeli	2½
ustoms at Enzeli, steam launch to Pir-i-Bazaar, carriage to Resht, and arranging for journey	1
	12½

This represents the shortest time with no elays on the way, and immediate embarca-on at Odessa in the weekly steamer that touches at only three intermediate ports. At Baku also there must be no time lost, and as there is no "connection" between the services of the two companies (the Russian Navigation Company on the Black Sea and the Kavkaz-Merkur on the Caspian) this can only be the case by a happy coincidence. If going by Constantinople, instead of Odessa, the time is the same, but the connection at Baku is equally uncertain. A route that is much adopted is the one by Petrovsk (London-Berlin-Moscow, 4 days; Moscow-Petrovsk, 4; Petrovsk-Enzeli, 5; Enzeli-Resht, 1; together, 14 days). The steamer from Petrovsk to Enzeli remains 48 hours, and sometimes longer, at Baku. Notwithstanding that delay, this route will be found the shortest in most cases, and certainly the more reliable one. The two or three days lost at Baku can be avoided by going from Moscow to Vladikavkaz; thence by carriage along the beautiful military Georgian road to Tiflis (24 hours, including a rest at Mlete) and to Baku by train (18 hours). But this route is uncomfortable in winter and in spring.

There is a weekly service between Petrovsk, Baku, and Enzeli in summer, and a fortnightly one in winter, besides numerous cargo boats. The mail steamers touch at Lenkoran and Astara. The larger ones of the steamers that are employed on this line, for instance, the *Imperator Nicholas II.*, which runs 13 knots, and is a most comfortable boat, could perform the trip (from Baku) easily in 20 hours if going direct.

With post horses the ride from Resht to Kazvin (carriage as far as Ziah rud) takes from 30 to 36 hours, according to the state of the road, and from Kazvin to Teheran by carriage requires 16 hours under ordinary circumstances. In fair weather 48 hours is a reasonable allowance for the whole distance Resht-Teheran, but this demands some perseverance.[35] When the road is fully organised it will be quite possible to reach Teheran from Resht without exertion in a day and a half. At present, in case of need, and if all goes well, Teheran can be reached from London within two weeks. When the railway Petrovsk-Baku is opened (which will be the case in about a year) and if direct steamers are put on the line to Enzeli, the journey will be further reduced by about four days. This will no doubt for many years to come be the quickest time.

[34] The Caspian at Enzeli is very shallow for more than 300 rds from the shore. Steamers have, therefore, to anchor at me distance, and if a strong wind is blowing it is impossible load or unload. It often happens that passengers for esht have to return by the steamer to Baku. Last winter me English travellers had the rather unprecedented experience of making the voyage twice in vain. It was only ter the completion of a third journey from Baku that they cceeded in landing. In such cases it is often advisable to nd at Astara, which has a better protected roadstead. Mr. . de Windt, in his "Ride to India . . . " describes the ad from this (the frontier) town to Resht, which takes three ys by caravan.

[35] One of the couriers of the British Legation at Teheran is in the habit of performing this distance in 30 hours.

It has been suggested that the *tracé* of the new road to Resht could be used for a Decauville railway, but this is not the case. The turnings are so abrupt, and there are so many of these, that a railway along this road is out of the question.[36]

If the plan of a railway to Teheran does exist, it will be rather carried out by gradual extension of the line Petrovsk-Baku to Astara, along the Caspian Sea to Resht, and then by Kasvin to Teheran. In the fulness of time the Caspian coast line will have to be prolonged to Astrabad and some point on the Trans-Caspian Railway, say Kizil Ararat, to be followed later on by the equally political line, Teheran-Yezd-Kerman, to some point on the Arabian Sea, say Chahbar, which is more accessible and less unhealthy than ports further north.

From the north-west Russian railways are approaching Persia at a rapid pace. The Tiflis-Alexandropol-Kars line is very nearly completed, and it has been decided to construct a branch line from Alexandropol to Erivan. From the latter place to Tabriz the distance is only 209 miles, and there are no engineering difficulties to overcome except the bridging of the Aras at Julla.

The shortening of the time occupied by goods to travel from the Caspian to Teheran will have far-reaching consequences for the current of trade in Persia.[37] The object aimed at by the measure of closing the Caucasus against transit for Persia (whilst remaining open for the transit of Persian goods for Western Europe) will be attained, and Russian goods will be enabled to penetrate farther into Persia, whereas imports by way of the Gulf ports and Bagdad or Trebizond will not be benefited. Teheran, already the most populous centre in Persia, will become of greater importance as a distributing market. The exports to Russia of dried fruit from the neighbourhood of Kazwin, and of cotton, will be further stimulated,[38] a altogether the commerce between the t neighbouring countries will gain about much as the importation from the south a the west will lose.

Considering the indifference shown by En land in assisting Persia in providing go communications from the South, there nothing in this course of events that ought surprise us. "For many years (in Lord Curzon words) "Persia has alternately advanced a receded in the estimation of British statesme occupying now a position of extravagant prom nence, anon one of unmerited obscurity. one time she has been the occasion or t recipient of a lavish and almost wanton prod gality; at another she has been treated wi penurious meanness. Public opinion in th country and in India with regard to Persia politics has been either at a white heat, or ha subsided into an inert stupor."[39] Englis aspirations in Persia seem to have entered f some time into the latter state. Last spring however, through the able exertions of tl Hon. C. Hardinge, who was in charge of tl Legation during the absence on leave of tl Minister, Sir Mortimer Durand, a step in th right direction was made by securing th opening of the much-discussed trade rou from Shushter to Isfahan through the Bakhtia country. The situation was favourable, an was taken advantage of. The present chie of the still mighty Bakhtiari tribes,[40] followin the intentions of the late Husein Kuli Khan had begun to show increasing willingness t facilitate the creation of a high road throug their dominions. Their former power had bee undermined. Incessant quarrels between th tribes after the execution of Husein Ku Khan in 1882, aided by the traditional polic of the Central Government: *divide et imper* had gradually resulted in impoverishing ther and breaking their pride.[41] Recently there ha

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[36] The concession for the road provides that the company will have the preference for a railway from the Caspian to Teheran. Should others offer better conditions, and obtain the concession, they will have to compensate the company by the payment of a sum of money, the interest of which, at the rate of 5 per cent., will be equal to the average earnings of the road.

[37] A calculation made some time ago resulted in the curious fact that the freight (in summer, *i.e.*, using the Volga) for cotton goods from Moscow to Isfahan was almost exactly equal to that paid from Manchester by way of Bushire. Isfahan is about equidistant from the Caspian Sea and the Persian Gulf. It is thought that the new road will reduce by one-half the present freight between Resht and Teheran. This result is arrived at as follows:—A horse carries, on an average, 8 poud, but it can draw 24—in fact, two draught horses can transport 50 poud. This difference allows amply for cost and wear and tear of the cart.

[38] The importation of these and other Persian produce assisted by Russia by means of low import duties, as com pared with what is charged for the same articles importe from other countries.

[39] "Persia," by the Hon. G. N. Curzon, M.P., vol. i p. 605.

[40] The principal chiefs at present are: the *Ilkhani* Imam Kuli Khan, brother of the late Husein Kuli Khan; th *Ilbegi*, Isfendiar Khan; Sardar Asad, eldest son of Husei Kuli Khan; Hajee Ali Kuli Khan, brother of Isfendiar an *Sertip* of the Bakhtiari horse at Teheran; Reza Kuli Khan a brother of Husein Kuli Khan, and Governor of Cheha Mahal; his son the Kargham es Saltaneh. The latter tw chiefs are on bad terms with the others.

[41] For a full and fascinating account of the Bakhtiaris and their ancient and modern history see "Persia," by the Hon G. N. Curzon, M.P., vol. ii, pp. 263-303.

[be]en famine in places as far south as Ram [Ho]rmuz and Behbehan, and great numbers of [ho]rses and sheep had died. Apart from [pol]itical motives (*i.e.*, a wish to come into [clo]ser relations with England as a bulwark [ag]ainst oppression), they had begun to realise [tha]t continued isolation would in the end lead [to] extinction. Even in those inaccessible [re]gions a wish for greater prosperity by legiti[ma]te means had taken root: at least among [th]e leaders. On the other hand, the Govern[me]nt at Teheran was not likely to raise any [ob]jection to a scheme which would slowly but [su]rely implant their authority over a people [wh]ich hitherto had successfully resisted all [enc]roads on their rugged independence.

As a result, and after protracted negotiations, [it] was arranged, with the sanction of the Shah's [Go]vernment, and of the British Legation, that [th]e tribes would enter into a contract with an [En]glish firm on the following conditions:—The [fir]m would advance the necessary funds (about [£]5,500) to build certain bridges, the revenues [of] the road would consist in tolls to be levied [o]n all animals passing with loads, viz., camels [an]d mules 5 krans (2s.), donkeys 3 krans [(1]s. 2½d.), per load; the tribes would guarantee [th]e safety of the road and 6 per cent. interest [o]n the money spent, which guarantee the [T]eheran Government undertook to enforce in [ca]se of need; they would further contribute [la]bour for the improvement of the passes, and [w]ould maintain them in good working order. [T]hey also promised to provide the necessary [m]ules for the traffic: a valuable condi[ti]on, as it will take time to instil sufficient [co]nfidence in the minds of the much-suffering [m]uleteers to make them abandon their present [h]aunts for the dreaded Bakhtiari country.[42] [N]o provision was made for the building of [c]aravanserais, but it is thought that in summer [th]ere is no great need for these, and during the [b]ad season the road will, unfortunately, not be [a]vailable, as the snow in the high passes will [st]op all transport.[43] It is hoped, however, that [g]radually the large traffic on the Bushire-[S]hiraz-Isfahan route (estimated at 30,000 mule [l]oads annually) will be diverted to this new road, in which case caravanserais will be built as a matter of course, and a continual stream of caravans would no doubt prevent the snow from settling. Some travellers have formed a less optimistic opinion.

The firm of Messrs. Lynch Brothers, of London, with branches at Bagdad and on the Karun (the Tigris and Euphrates Steam Navigation Company, Limited) were found willing to enter into the enterprise on those conditions, and on behalf of the tribes the contract was signed (March, 1898) by Hajee Mohamed Khan (the Sefardar), Isfendiar Khan (Sardar Assad), and Hajee Ali Kuli Khan (the Sertip of the Bakhtiari Horse at Teheran).

It may be useful to precede the itinerary of the intended road by a brief summary of recent journeys from Shushter to Isfahan, and *vice versa*. In recent times, the road has been described by several travellers. Mr. George S. Mackenzie was the first who tried to extend to practical purposes the fact that Isfahan is some 220 miles nearer Shushter on the Karun, than to Bushire on the Persian Gulf. He travels from Isfahan to Shushter, by way of Ardel and Dopulun in 1875, and three years later he goes in the opposite direction by Bazuft.[44] At that time, the Lower Karun had not been opened to navigation, and it was not found possible to utilise the practical experience gained by these journeys. In 1877, General Schindler travels from Shushter to Isfahan, and describes his journey in a detailed manner.[45] His account is accompanied by an excellent map. The itinerary gives 291 miles, as compared to 267 by Mackenzie (first journey), 277 by Wells, and 249 by Lynch; but the difference is accounted for by the more southern route adopted between Shushter and Malamir by Joru (121 miles) instead of by Gurgir (78 miles). From Dopulun he selects the Naghan and Chigakhor route, instead of the more northern one by Ardel.

In 1881, the late Colonel (then Captain) H. L. Wells, R.E., goes from Isfahan to Shushter by way of Kahu-i-Rukh, Shelamzar, the Gerdan-i-Zerreh, Ardel, Dopulun, Malamir, Gurgir, and gives a critical description of the difficulties of improving the mountainous parts into a trade route.[46] The Lower Karun was declared free to all flags in October, 1888, and in the latter half of the next year, Mr. H. F.

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42 The Bakhtiari breed of mules are the best in Persia, and [p]erhaps in the world. They are not big, but compact and [v]ery strong. Until a few years ago they have been bought by [th]e Indian Government in such numbers that the supply for [c]aravans ran short, and mule carriage in central and southern [P]ersia rose considerably.

43 Well mounted travellers can get through sometimes; as [d]id Major Bruce and Lieut. Macinney in 1890. Last winter [th]e snow was very high, but a Ghulam succeeded in making [h]is way from end to end.

44 See "Proceedings of the Royal Geographical Society," March, 1883, p. 132.

45 "Zeitschr. der G. fur Erdk." 1879, Map.

46 "Proceedings of the Royal Geographical Society," March, 1883, Map.

B. Lynch, whose firm had been the first, almost immediately after the publication of the decree, to take advantage of this concession to Western pressure (thus repeating the introduction of the English flag on the Tigris by Commodore Blosse Lynch in 1862), makes his way from Shushter to Isfahan by Dara Kul, Gurgir, Malamir, Dopulun. He then adopts Schindler's route by Naghan and Chiga-Khor, but keeps more to the south than Schindler, and passes by Paradomba, the residence of the Ilkhani.[47] Others have travelled between Shushter and Isfahan, but their accounts may be considered to be superseded by those mentioned above. Their names and works have been fully noticed in the publications referred to.[48]

The complete itineraries of four of the journeys, of which the main features have been mentioned, will be found on p. 355.[49]

The four routes all vary as far as Malamir, where they converge.

If starting from Shushter, Lynch's is undoubtedly the shortest, but the river from Ahwaz to Shushter (Shelalieh, on the Gurgir) is tortuous (by water 90 miles, by land miles), and as transhipment is required Ahwaz, on account of the rapids, it has be decided to begin the land transport at t latter place. Following the river as far Weiss (14 miles), the road then strikes acr to Kaleh-i Tul, probably by Rud Zerd, Kalg and Bagh-i Malek (see Schindler's and Well routes), and thence to Malamir. There is or one road from there to Dehdiz, by Guda Balutak, where a bridge will be built to cro the Karun. From Dehdiz to Dopulun t Shelil route will have to be taken, as Wel who went by Rudbar, admits that the form route, taken by Mackenzie and Schindler, the easier of the two, and Lynch, who cho the one by Sarkun, explains that he had to so on account of the ruined state of the brid at Pul-i Amarat, where the Ab-i Bazuft has be crossed to reach Shelil. This bridge is no being repaired.

At Dopulun, where the brick bridge, built b the Ilkhani, is in good repair, the differe roads once more meet. Of the three or fo paths that lead from here to Kahu-i Rukh, large village belonging to Isfendiar Khan, th one by the Ardel Pass will, no doubt, b chosen, but in order to avoid the 9,300 fe high Gerdane-i Zerreh pass, "a rough an very steep track, only passable for mules, an blocked even for them in winter" (Wells), th road cannot go from Ardel to Tishniz, but will make a detour to the north, and pass b the Teng-i Darkash Warkash, and probabl Chulcheh (Mackenzie's second journey), Sirek and Shehrek.

From Kahu-i Rukh the road reaches Isfaha without further difficulties by Lajebid, Bagh Wahsh and Pul-i Wargan.

However grateful we may be for the energ displayed by H.M. Legation at Teheran, i securing this new trade route, giving access t the interior of Persia from the south-west, an whatever may be ultimately the politica advantages, it cannot be denied that, fo commercial purposes, the undertaking com pares unfavourably with what Russia is doin in the north. The £5,500 which will be in vested in the Bakhtiari road cannot hope t compete in results with the £340,000 that is t be spent between Resht and Teheran (wit Hamadan in the background). The questio may be asked whether the relative importanc of these figures is to express the value in whic the two countries hold the Persian trade whic they divide between them?

At all events, the road that is now in cours

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[47] "Proceedings of the Royal Geographical Society," September, 1890, Map.

[48] It is not necessary to refer here in detail to the extensive journeys in the land of the Bakhtiaris by Prof. Haussknecht in 1868. He published his map in 1882; Col. Bell, 1884; Mrs. Bishop, 1890; and Captain Burn, 1894. Of these travellers, the last-mentioned alone traversed the whole route (*vide* J. As. Soc. of B., 1897, No. 3), the others branching off to the north or south before reaching Shushter. Mr. J. R. Preece, H.M. Consul at Isfahan, travelled, some years ago, from that town to Shushter by way of Pul i Wargan, Kahu i Rukh, Shelamzar, Naghan, Dopulun, Hilisat, Pul i Amarat, Deh Diz, Malamir, Malseyidi, Gurgir, Beitavand, but the report of his journey has not been published.

[49] For comparison they have all been given as from Shushter to Isfahan, although Wells travelled in the reverse direction. The spelling has been made uniform following that adopted by Curzon. Mackenzie's second journey (1878) by Bazuft has not been included, because this northern route was only employed (and is still frequented by the tribes in their annual migrations with their numerous herds), in order to avoid the passage of the Karun on rafts at Gudar-i-Balutak, whereas, in the present road scheme, a bridge at that place is the leading feature. The Bazuft road is "far more difficult in winter, owing to the high elevation it crosses. In fact, it is said to be impassable at that season." (Wells.) The stages of Mr. Mackenzie's second journey are:—

	Farsakhs.		Farsakhs.
Shushter	—	Ab-i Enari	2
Gotwend	4	Guelle i Kedjuz	3½
Bam-i Ferra	2½	Bazuft	2½
Lâlee	3	Mowarz	2
Teng-i Baba Ahmed ...	4	Hul-i Zamanek	3½
Chulbar	3½	Maze-i Khaki	3
Pa-i Monar	2	Kurun	2½
Shimbar	3	Al-i Kuh	2
Chillaw	2	Chulcheh	5
Mori	4	Kahu-i Rukh	5

This itinerary is delineated in Schindler's map.

construction will be a very poor substitute the Karun one. Travellers' accounts)und with references to the physical diffi- ties met with. General Schindler, who ited both the Bakhtiari and the Karun roads the Shah's order, with the object of erect- a telegraph line between Shushter and the)ital, unhesitatingly selected the latter. The Colonel Wells, who, by his extensive vels in Persia, was well qualified to form opinion, has pronounced against it both on ount of the uncompromising formation of ground, and of the absence of towns or ages of any importance on the line of rch. The road will for ever remain a mule ck. Wheeled traffic is out of the question, l a railway by this *tracé* still more so, con- ering that about 80 miles to the north the intry is all but level, between Isfahan and tanabad, by way of Khonsar, and is ex- lently adapted for railway building.[50] The)ulation, sparse as it is, has no elements in character that are reassuring in relation to itical economy. The various objections to road may be found summarised in the :ount of the address delivered by Lord rzon of Kedleston at the Royal Geo- phical Society meeting of 12th May, 0.[51]

t is, however, as well to remember that re is no immediate prospect of the con- iction of the Karun road, and not to forget t "the half is more than the whole." If Bakhtiari chiefs keep their word, if they tribute labour and mules, and if they keep road safe, and will indemnify merchants l travellers for any pilfering or robbery occurring in their districts, then the enterprise will, at all events, be an improvement during the fair weather months on the existing Bushire-Shiraz-Isfahan road, the first section of which is of the most deplorable description.[52]

Besides, however insufficient it may be as the main trade route from the south, the new road offers possibilities of a more local nature, that need not be overlooked, and which make it well worth the small investment that is being made on its behalf; this money, in fact, will not have been spent in vain if it assists in settling the Bakhtiaris and in opening up trade with them.

Yet, the chief advantage of the opening of the Bakhtiari route will be the impetus it is sure to give to the traffic on the Karun, which

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Sultanabad is about 75 miles from Hamadan which is on ine of the important trade route from Bagdad to Teheran Khanikin and Kermanshah, and it is believed that it is g this line that the only possible self-supporting railway be built that is to give access to Persia from the south. ength would be roughly 500 miles; it would serve the pilgrim traffic to the Shiah shrines of Kerbela and f, and it would be connected with the Persian Gulf by is of the existing steamship lines on the Tigris. It has been proposed to continue the intended prolongation to lad of the Anatolian line, on to Bassorah and even eit, but it would be much less costly and answer the rements sufficiently well, as far as Persian trade is con- d, to put a larger number of steamers on the Tigris, ly the Turkish Government would give the necessary ission, or increase and improve their own fleet of river iers. (Strange to say, like the Turkish Empire, they been in a precarious position from time immemorial, but iey remain afloat.) The banks of the Tigris ought also seen to. At present its water is much wasted, and g the summer there is too little for even the very light ht steamers that are in use.

'Proceedings of the Royal Geographical Society," mber, 1890, p. 523-4, also discussion.

52 In the matter of distance also this road compares unfavourably with the new road. The approximate figures are:—

From	To	Miles.	Caravan Stages.	Days.	Highest Pass.	Feet.
Bushire ...	Shiraz ..	170	12	—	Kotel-i Pirazen	7,440
,, ..	Isfahan ..	482	27	—	Dehbid	7,500
,, ...	Teheran ..	757	39	—	Kuhrud Pass	7,250
,, ..	Mohammerah	117	—	¾	steamer	—
Mohammerah	Ahwaz	117	—	1–2	river steamer	—
Ahwaz ...	Isfahan, *viâ* Ardel ...	260	15	—	about	8,000
,, ...	Teheran, *viâ* Ardel and Isfahan ..	572	27	—	about	8,000
,, ...	Isfahan, *viâ* Burujird ...	502	28	—	Dehliz Pass (many short stages)	5,750
,, ...	Teheran, *viâ* Burujird ..	533	35	—	ditto	5,750
Mohammeral	Bassorah ...	22	—	¼	steamer	—
Bassorah ..	Bagdad ...	510	—	5	river steamer	—
Bagdad ..	Isfahan, *viâ* Kermanshah and Burujird	55[illegible]	33	—	Teng-i Girra	4,630
,, ..	Teheran, *viâ* Kermanshah & Hamadan	51[illegible]	31	—	ditto	4,630

For comparing the time occupied on the three routes from the coast to Isfahan and Teheran, two days should be added to the routes starting from Ahwaz to cover the time required for the steamer to discharge cargo at Bushire and for the voyage from that port to Mohammerah. On the Bushire-Teheran road the number of stages does not correspond with that of the days required. Caravans take on an average sixty days for the whole road.

will result in an improved state of things at Ahwaz and Shushter. With increased trade at those places, which in former times used to be important centres,[53] the want will be felt of further developments, and it may be that in this way the Ahwaz-Isfahan road will in the end be the means of obtaining the much-desired road from Ahwaz to Teheran. This latter one will always remain the ultimate aim. Its advantages are numerous, and may be recapitulated as follows :—

1. The road will be easier to construct, the passes are less formidable, and will be kept open more freely during the winter. Wheel traffic can be arranged for at a comparatively small additional outlay, and it should always be borne in mind that of whatever value may be, even in Persia, the gain in time of a few days, yet it is of still more importance to prevent the daily unloading of mules, &c., during the long marches (causing breakage), and to enable the transport of heavy pieces of machinery for industrial purposes.[54]

2. It will traverse well-watered provinces, of which the chief centre is Dizful, that now trades by way of Amarah on the Tigris, and pass by Burujird, the centre of a very fertile district; Sultanabad, the chief town of a prosperous province with a flourishing carpet-weaving industry; Kum, a noted shrine. The trade of the important towns of Hamadan and Kermanshah (surrounded by districts that produce wheat in abundance) will be tapped, and by a branch road starting from near Burujird it will be connected with Isfahan (210 miles). Finally, it will have for its terminus the capital, with an increasing population of over 200,000, and destined to become more important as a trade centre as soon as the Resht road is completed.

3. The Karun road will not be so much at the mercy of semi-independent chieftains. It is only on part of the road between Dizful and Khorremabad that the Feili Lurs may be said to require attention, and a few military posts or some small subsidies to the chi would no doubt be sufficient to keep the under control. In this part of Luristan t tribes are far from being so powerful, unite and unassailable as their Bakhtiari kindre and they are, therefore, more likely to submit the inevitable.

Colonel Bell, who has visited both t Karun and the Bakhtiari roads, is an enth siastic believer in the former. He sums his careful investigation by declaring th "the line Mohamrah, Dizful, Khorremaba Burujird, Sultanabad, Kum, Teheran, m be considered the main commercial artery Persia," and he gives a comparative stateme of distances to prove the accuracy of l verdict.[55]

The Indian Government has for some yea paid a subsidy for the maintenance of a fo nightly steamer service between Mohammer and Ahwaz. If the new road should reali the expectations that are formed of it, tl subsidy could probably be dispensed with, a the money could certainly be employed better purpose as a means to enable t Government to guarantee the interest of t required capital to build a road from Ahw to Teheran, utilising the concession that now in the hands of the Imperial Bank Persia. It has also been proposed to use t money to subsidise the Lur chieftains on co dition that they keep the road safe. It thought that £1,000 to £1,200 a ye judiciously distributed would attain tl object. But there would be then funds available for guaranteeing inter on capital, and the road would remain mule track. On the other hand, the existi concession to the Imperial Bank of Per would be left undisturbed, and if the measure subsidising the tribes succeeded, it wo enhance the value of this concession, a would perhaps make it possible after a ti to raise the necessary capital (without Gove ment guarantee) to build a well metalled ro for wheeled traffic all the year round.

There is no reason to fear Russian opposit to this road. In fact, the commercial posit of Russia will become so strong by the co struction of the Resht road, that the stimulat question will arise, which trade will be m assisted by the Karun road; that from North or that from the South.

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[53] Under the Abassides, Ahwaz was a most prosperous town, and the province produced sugar and grain in very large quantities. (*See* "Ainsworth's Personal Narrative," vol. ii., p. 229-7.) Now the stagnation here and at Mohammerah forms a sad contrast with the prosperity of the neighbouring port of Bassorah.

[54] The freight on bulky or heavy pieces is enormous. These have at present to be sent *viâ* Bagdad-Khanikin (the hotels between Bushire and Shiraz are quite impracticable). A cottage piano, sent some time ago to Teheran, cost to send from Bagdad to Kermanshah (220 miles) £12 11s.; two safes of ordinary size, £31 for the same distance.

[55] "Blackwood's Magazine," 1889.

Mackenzie, 1st Journey, 1875.		Schindler, 1877.		Wells, 1881.		Lynch, 1389.	
Stations.	Miles.	Stations.	Miles.	Stations.	Miles.	Stations.	Miles.
ushter	—	Shushter	—	Shushter	—	Shushter	—
leh-i-Tul	95	Shekerab (fairly good)	32	Shekerab (level)	30	Dara Kul	$22\frac{1}{2}$
—	—	Joru (fairly good)	35	Gurgir (good)	14	Gurgir	$29\frac{3}{4}$
—	—	Kalga (bad)	$17\frac{1}{2}$	Rud zerd (good)	20	—	—
—	—	Bagh-i Malek (very bad)	11	Kaleh-i Tul (good)	13	—	—
						—	—
—	—	Kaleh-i Tul (good)	$7\frac{1}{2}$	—	—		
lamir	14	Malamir (good)	18	Malamir (good)	$15\frac{1}{4}$	Malamir	26
dar-i Balutak	21	Gudar-i Balutak (very difficult)	$24\frac{1}{2}$	Gudar-i Balutak (could be improved)	24	Gudar-i Balutak	$22\frac{3}{4}$
hdiz	9	Dehdiz (good)	$10\frac{1}{2}$	Dehdiz (easy)	$10\frac{1}{2}$	Dehdiz	$11\frac{1}{2}$
elil	14	Shelil (very difficult)	15	Rudbar (parts very difficult)	12	Sarkun	$24\frac{3}{4}$
—	—	Gendum-Kal (very bad)	$11\frac{1}{3}$	Hilisat (fair, but a precipitous bluff)	15	—	—
pulun	$17\frac{1}{2}$	Dopulun (very difficult)	$10\frac{2}{3}$	Dopulun (rough)	19	Dopulun	$16\frac{1}{2}$
del	9	Chiga Khor (good)	$20\frac{1}{8}$	Ardel (very bad)	7	Chiga Khor	$21\frac{3}{4}$
hru	14	Kharedji (good)	$14\frac{1}{4}$	Shelamzar (very bad)	$19\frac{1}{2}$	Paradomba	19
erak	$17\frac{1}{2}$	Kahu-i Rukh (good)	$15\frac{1}{3}$	Kahu-i Rukh (fair, one bad bridge)	25	Dauletabad	$31\frac{1}{2}$
ebid	28	Bagh-i Wahsh (fairly good)	$31\frac{2}{3}$	Chirmini (rough, bad kotal)	17	—	—
—	—	—	—	Puli Wargan (good)	$25\frac{3}{8}$	—	—
han	28	Isfahan (good)	$16\frac{3}{4}$	Isfahan (level)	10	Isfahan	$22\frac{3}{4}$
stages, 267 miles.		16 stages, $291\frac{1}{8}$ miles.		16 stages, $277\frac{5}{8}$ miles.		11 stages, $248\frac{3}{4}$ miles.	

DISCUSSION.

e CHAIRMAN, in opening the discussion, observed the subject of the paper was an important one, would, he hoped, bring out an interesting dis- on. It seemed to him that the question was nded with exceptional difficulties on account of moribund condition of Persia, the want of money enterprise in that country, the peculiar formation round, which made it a sort of table-land sur- ded with difficult mountain ranges and hills, the nce of navigable rivers, and, last but not least, paucity of the population, seeing that London its suburbs contained almost as many inhabitants e whole kingdom of Persia, although in area it about five times larger than the British Isles. hared Mr. Hotz's regret that the so-called Karun me had not been carried out in its entirety, as it the least difficult route from the sea to the al, and would open up to trade the most flourish- nd best watered provinces of the kingdom. It only too true, as observed by Mr. Hotz, that, ut it in Lord Curzon's polite language, Persia "advanced and receded in the estimation of British statesmen;" and this arose greatly from the late Shah's fears of his powerful neighbour on the North, who put the screw on him the moment he favoured any scheme or any influence from the South. As now in China, in fact, so had it been in past times in Persia, although our efforts to open up trade routes in the latter country in times gone by were weighted, not only by the veiled opposition of the Shah, under Russian pressure, but by the indifference and, indeed, veiled opposition of our own Treasury, which, until quite lately, had acted on the principle that no one should pay for anything eastwards except the taxpayers of India. Thus, what little had already been effected in the Karun was more due to private enterprise than to the Government; such as the efforts of Mr. George Mackenzie, Messrs. Lynch, Messrs. Gray, Dawes, and others, with such little assistance as the Indian Government could give them. In considering this matter, however, it was only right to remember that for some years past both the Imperial and Indian Governments had been compelled to concentrate their attention on objects of greater importance, and nearer

home, than Persia. He, himself, remembered with interest, that when Sir Henry Rawlinson and himself were appointed to be with the late Shah during his visit to England in 1873, they had many important conversations with His Majesty on trade routes and other questions. Owing, however, to the Government then in power feeling unable to accord him the direct military protection he desired, he ceased to have any confidence in England, or any desire to see her in control of his southern trade routes and commerce, and, in fact, preserved a veiled opposition to both, for reasons already stated, till his death.

Mr. George Sutherland Mackenzie, C.B., said it was 25 years since he had travelled in Persia, since when there had evidently been many changes in the roads and other matters; in his time there were no wheeled vehicles in the north. He was the pioneer on the route from Ispahan to Shushter; there was a difficulty in those days in any European travelling in the Bakhtiari country, those tribes being supposed to be hostile and fanatical. He, however, did not find them so; the chief met him with a hearty welcome as an Englishman, and he travelled through the country in different directions, and always met with the greatest civility. He brought the subject under the attention of the Government, and pointed out the feasibility of navigating the Karun far enough to open up a direct route, and the Bakhtiari chief himself was anxious that this should be done, going so far as to give a letter of guarantee that if any caravan passing through his country were looted, any loss should be made good; he also offered to put down half the money for the steamer to navigate the river. Unfortunately, they could not get the Government support necessary to attract the capital required. A great deal of obstruction he believed arose from the commercial rivalry between Russia and England, one being played off against the other. It was a great pity that some common understanding could not be arrived at, because there was a natural dividing line between the sphere of influence of the two countries. He was pleased to hear what Russia was doing in the north, and if we would not do anything in the south, there was no reason why Russia should remain passive. The water base of the Black Sea was naturally Russian, and the Persian Gulf was English, and it was extraordinary that an intelligent people, like the Persians, did not see how much it would be to their own advantage to open the road in the south by the Karun valley; at present a great deal of the trade went by way of Bagdad, paying duty to Turkey. By opening up the direct route, she would at the same time open up an enormous tract of agricultural land in Kermanshah and Hamadan. Cereals could not pay the expense of carriage on mules for great distances. Through the energy of Messrs. Lynch, a great deal was being done to remove or minimise the difficulties which existed on the road from Ispahan to Shushter, which ought to supersede the circuitous route by way of Shiraz. So thought it would be better to make the road by w of Dizful and Khorremabad to Teheran; but it wo not meet the requirements of the Ispahan distri and he should say that both roads were necessa The great need in Persia was capital, and the gr difficulty was the want of security, for which t Persian Government was mainly responsible, becau there was no possibility of obtaining justice in Persian Court in any claim against a Persian subje It was this which had compelled his firm to cl their establishment in Ispahan, though with gr regret. They did not get the support of the Brit Minister in the same way as he understood Russi subjects did. Capital would not be attracted Persia until both the British and Persian Gove ments took steps to see that when contracts w entered into they should be carried out. The wh of the traffic had been carried on for many years the muleteers, of whom a photograph had be shown, and he should like to bear his testimony the excellent character of those men. Every o who travelled in Persia was much indebted to th for their kindness and civility, and their honesty w proverbial. When he was there, treasure was sent bags to Ispahan for the purchase of cotton a opium, and in no single instance did he hear of not being safely delivered. Of the people, general he could speak in high terms. There was no fan cism; nor did he know a pleasanter country to tra in. All the evils it suffered came from the Gove ment.

Mrs. Isabella L. Bishop said she had gr pleasure in corroborating what Mr. Mackenzie l said as to the muleteers of Persia. They wer splendid set of men, and their fidelity and hone were wonderful. During a year's travel she only o had occasion to find fault with them, and that w not on the ground of honesty. She had travel considerably in Persia, from Bagdad and Kermansl and Kum to Teheran, and thence to Ispahan, and four months was in the country of the Bakhti travelling from Dopulun up to the actual sou of the Karun, where seven springs break out a full-grown river under a limestone rock. The she went by Khorremabad to Burujird, which seen to her about one of the best centres of trade Persia, being placed in a most productive regi within 310 miles of Ahwaz, 92 of Hamadan, 130 fr Kermanshah, and 60 from Sultanabad, the centr the carpet trade. It is also within 140 miles Kum, on the direct road to Ispahan, or 230 fr Tihran, and there was no place in Persia wh seemed to present such openings for English tra provided only the road were made from Ahw From thence she went by Hamadan, and thro what is called Persian Khurdistan, to Oroom Whilst living amongst the Bakhtiaris, and ot nomadic tribes, numbering about 2,500,000 a gether, she was interested in noticing what sor

ngs they purchased, and where they came from. far south as Ardel and Dopulun one would expect find that the majority of imported articles were itish, but such was not the case. There were ıssian printed cottons in large numbers, mirrors, d light and heavy woollen cloths. What might called knickknacks from Russia were scattered roughout the Bakhtiari Lur tribes, and the ne thing among the nomads of Western Persia. gain, north of Burujird, and in that town itself, e visited many of the houses, and entered into nversation with the women about the prints e saw, which she learned were Russian, and inquiring why they were preferred, because e cost of carriage must be greater from ussia than from the Persian Gulf, she was told that e Russian merchants understood their taste better to colours and patterns; the Manchester prints ere large fiery patterns, with a great deal of scarlet them, which were probably intended to suit the pposed barbaric taste of Persians, whilst the Russian ints were in smaller and quieter patterns, and more bdued colours, which the Persian women wore with easure, because they gratified their refined taste. send staring patterns to Persia, where good taste proverbial, is the most absurd thing possible. erything in Persia depended on the roads. Coming m Bagdad to Teheran in the depth of winter, there ere 6 feet of snow on the road a good part of the ıy, and in some parts there was only one narrow ıck, and if caravans met one had to turn out into e snow, where very often the mules fell and were ıloaded. Yet there was a perpetual stream of ravans along that road; in one day she counted 73 ravans labouring along, containing from 27 to 100 ules, all loaded. Between Kum and Teheran there ere caravans of coffins floundering through mud two three feet deep, and almost impassable, so that n miles was a good day's work. Everywhere in ersia, during late autumn, winter, and spring, there as this horrible mud, through which everything had flounder—far worse than in China. Roads were idently the great requisite; and perhaps it would well for English trade if some of the money which emed to find some difficulty in investing itself, were nt to Persia for road-making, under the guarantees which Mr. Hotz had spoken. Her remembrances Persia were delightful, and she thought the Persians served a happier lot.

Sir THOMAS EDWARD GORDON, K.C.I.E., C.B., .S.I., said this was a very old subject, for the present ade routes of Persia were the same as in the days Darius, and the trading centres were the same, ough the names had changed, as new towns ıd sprung up on the ruins of the old, or near to em. This very road which was now being made om Shushter to Ispahan, was a line of commerce in ıtiquity, leading from Susa towards Persepolis. here had existed in all ages a great thoroughfare communication between Media and Babylonia, Hamadan and Bagdad, and he believed it would continue to be so. The first railway into Central and Southern Persia would enter by that route. An effort was made to open up a trade route from the Karun waterway at Ahwaz to Burujird, and beyond, as Mr. Hotz mentioned. The late Shah had entertained the idea, and hoped capital and trade would be attracted to it; under his orders General Schindler, in 1887, commenced work on the direct mountain route between Khorremabad and Dizful, improved the worst parts of the old track, erected a telegraph line, built a few caravanserais, and arranged with the marauding Lur tribes, through whose territory the road passed, a paid system of "watch and ward" for the protection of trade and traffic. This was supposed to prepare the way for a cart road, and to establish firmly the Shah's authority over the predatory tribes. When he (Sir Thomas Gordon) went along the route in 1890, accompanied by the engineer of the proposed new road, they found that a cart road would be impossible the whole length of the line, and that a considerable deviation would be necessary. Owing to weak Provincial administration, and the complaints of the tribesmen that the promised payments for the preservation of order had not reached them, the telegraph line was broken, the road became unsafe, and the Lurs reverted to their old state of chronic rebellion. The same state of things seemed to exist there still. The telegraphic communication with Shushter and Ahwaz is now carried on from Teheran *viâ* Shiraz and Behbanan. In the old days of Susanian prosperity, this direct route was not used for general trade and traffic. For communication with the fertile plains beyond the mountains, a circuitous, commodious, and easy route along the foot of the Zagros range was followed. This joined the route from Babylon, which avoided traversing the several parallel ridges of that range, and gave access to the great plateau of Persia by one single pass. There were evidently quite as good practical students of physical geography in those days as in our own Examination of the Bagdad-Teheran road shows how easy this ancient route is, and that it is the natural outlet for Kermanshah and Hamadan. The Messrs. Lynch deserved great credit for improving the old trade route from Shushter to Ispahan; it was a well frequented route in the days of Darius, and the Bakhtiaris, through whose country it passed, had come to follow a certain system of trade and traffic, and so became humanised. While their Lur brethren in the north-west had remained semi-savage, the Bakhtiaris had advanced into civilization, and become in some ways a romantic and attractive people. He was very glad to hear they were partners in this road enterprise. We had been been told of Russian trade beating back English trade, and of Russian road enterprise. He passed over the Russian road in November last; it was a fine piece of work, and looked like one of the great Caucasian military roads; but that road was only for Russian traders, whilst the wide "open door" in the south was for

the commerce of the world. Some of the goods which entered in the south, however, were erroneously supposed to be from Manchester. A consular report about two years ago mentioned the fact (with which he was acquainted) that Manchester goods of certain descriptions, long well known in Persia, were being imitated by goods coming from Holland, and bearing the same well-known trade marks of the Manchester goods. It could hardly be expected of the British Government to build and subsidise roads in Persia if the result was to assist in this way the commerce of the Continent. He thought road-making in Southern Persia would have to be done by private enterprise, with the partnership of Persian subjects, as in the Shushter-Ispahan road, and the British merchants should try and put a stop to the piracy of their trade marks.

Sir Lepel Griffin, K.C.S.I., said no one who, like himself, had had a great deal to do with Persia, and who had some experience of road making there, could fail to realise the importance of the subject which Mr. Hotz had so ably brought forward; and no one could see his photographs without understanding what was the initial and final difficulty in carrying out any work in that country. You saw irrigation dams a thousand years old, and bridges many hundred years old, every ancient building, and every public work of importance falling into decay and ruin, for want of a central government which would spend money on their repair. That had been, and would continue to be, the difficulty. The Imperial Bank of Persia, with which he was connected, had a concession for the road about which so much had been said, from Teheran through Kum, Sultanabad, and Burujird, to Ahwaz and Mohammerah, the great road of the south to which they all looked for the development of English commerce. Although what Mrs. Bishop and Sir Thomas Gordon had said with regard to the road by Bagdad and Hamadan was no doubt correct, there were many things to be considered besides difficulty of construction. The question of guarantee had been alluded to by the Chairman, who truly said you could not expect the British Government to guarantee undertakings in all parts of the world. Still there were some who thought that the Foreign Office might make an exception to its general rule in favour of certain roads, which were essential to British commerce, and without which our trade from the south would be entirely overborne by the trade from the Caspian and Russia coming down the new road from Resht. The line which divided Russian trade influence in Persia from English was differently placed by different people; but, as a rule, the latitude of Ispahan was about the limit of English trading superiority. At Teheran and to the north, and still more in Tabriz, Russian goods had the advantage from their propinquity to the frontier, and it would be useless to attempt to compete with Russia in the extreme north. The last time he had the pleasure of hearing Mrs. Bishop speak was at a meeting over which he p sided at the United Service Institution, the subj being Manchuria; and the question of Russia a Manchuria then was the same as that of Russia a Northern Persia to-day. We could no more opp the influence of Russia in Northern Persia than could in Manchuria, and it was unwise to attem it. He quite agreed with Mr. Mackenzie that would be well to come to some frank arrangeme with Russia whereby our several spheres of influen in both parts of Asia might be determined. Witho that he was sure there would be great if not insupe able difficulty.

The Chairman having proposed a cordial vote thanks to Mr. Hotz, which was carried unanimousl

Mr. Hotz, in responding, said he had been mu interested in the discussion, which was very valuabl but there were only two points on which he shou like to say a word. He agreed with Sir Thomas Gord that the route which he had alluded to from Bagd to Teheran was the natural route for a railway, whe ever it was built; but the 1 per cent. which had to l paid to the Turkish Government was a drawbac from a commercial point of view. Besides, th route is often closed by the Turkish Government c the merest pretext of contagious disease in Persi The question of roads might be looked at eith politically or commercially, and as a merchant h looked at it from the latter standpoint. He shoul think the road from Ahwaz to Kum (the Karu road) was the best route, because it went through th most fertile districts, and it could, later on, be easi connected, by way of Burujird, Nihavend, an Kangawar, with the railway which may here after be built from Bagdad. With regard t Dutch goods in Persia, he was afraid the co sular report was somewhat exaggerated. His fir naturally bought in the cheapest market, but the could only buy white goods in Holland at any ad vantage, not prints, and even those white goods wer in many cases made in England, and only sent t Holland to be bleached.

Mr. Hotz writes further:—I find that I hav omitted in my reply to refer to Sir Thomas Gordon' remark that, with regard to the importation c Dutch goods in Persia, merchants should "tr and put a stop to the piracy of trade-marks." I may be well to explain that there is no occasio for any display of energy in that direction. Th marks which these Dutch goods bear are thos of the importers or consignees. They are their ow marks which they put on all the goods that they sen to Persia, whether they are made in England or else where, and they have of course a perfect right to do s The Consular Report which Sir Thomas Gordon ha referred to mentions, in connection with the importa

of Dutch goods, that: "The trade-marks are the e as on those hitherto imported from Manchester," ıning the marks of *importers*, not of manufac- ırs. This makes all the difference, and has evi- tly caused the misunderstanding. The following ıle, taken from the latest Consular Report (Annual ies No. 2186), will confirm my assurance that re is no cause whatever to fear that Manchester is ıg superseded by the Continent:—

AL VALUES OF IMPORTS FROM PRINCIPAL COUNTRIES, IN THE YEAR 1897, AT BUSHIRE, LINGAH, BENDER-ABBAS, ALL PORTS IN THE PERSIAN GULF, AND AT MOHAMMERAH.

Country.	Value.				
	Bushire.	Lingah.	Bender-Abbas.	All ports in the Persian Gulf.	Mohammerah.
	£	£	£	£	£
ited Kingdom ..	773,883	584	64,517	862,297	29,616
lia	208,503	287,502	283,778	1,158,083	63,607
ınce	56,199	—	14,062	70,251	4,955
rkey	25,819	25,335	4,593	188,102	16,535
rsian Ports	27,491	39,588	4,806	328,273	—
ıscat	11,219	14,215	4,531	69,261	2,445
ina...........	10,950	—	—	10,950	—
stria	2,133	—	—	2,133	4,249
lgium	764	—	—	764	—
ssia	750	—	—	750	—
ypt...........	10,605	—	—	10,605	—
hrein...... ..	13,140	9,296	937	32,172	—
nzibar	1,591	719	175	4,911	—
rmany	1,982	—	—	1,982	—
ab Coast...	—	205,233	4,153	223,526	—
Total	1,145,329	582,472	391,562	2,964,070	121,407

The reports from Basjorah (and Bagdad) do not give a ıble of "Principal Countries."

ı no case is Holland, among other countries, men- oned in this Table: the reason being that her ex- ırts to Persia are sent *viâ* England in transit. (They e therefore subject to the Merchandise Marks Act, ıd bear the inscription, "Made in Holland.") I ıould say not more than about £8,000 worth of white ıd grey goods are imported annually from Holland, ıd of prints none whatever, because Dutch printers e only organised for the Java and adjacent markets; ıey do not produce any of the designs required for ersia. There is no reason to think that an increased ade by means of new roads from the South will ter the state of affairs shown by the above Table. Vherever new roads are made and doors opened, nglish merchants as a rule manage to secure by ıeir energy a very fair share of the new business. Vhy then should it be supposed that they will not e able to do the same, and to hold their own on the Carun road, when it is built, as well as on that ırough the Bakhtiari country?

THIRTEENTH ORDINARY MEETING.

Wednesday, March 8, 1899; HILARY BAUERMAN, Assoc.Mem.Inst.C.E., F.G.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Greg, Ernest William, Higher Dunscar, near Bolton.
Lorrimer, Maurice, The Spinney, Coundon, near Coventry.
Samuel, Alderman Sir Marcus, 20, Portland-place, W.

The following candidates were balloted for and duly elected members of the Society:—

Grove, A., 2, Albion-street, W.
Hill, Arthur Frederick, 140, New Bond-street, W.
Johnson, Sir Samuel G., Nottingham.
Lupton, Arnold, 6, De Grey-road, Leeds.
McCaw, W. J., Woodfield, Streatham-hill, S.W.
Whitbread, S. Howard, M.A., J.P., Southill, Biggleswade.
White, Franklin, Hazlewood, Keynsham and Johannesburg.

The paper read was—

CORNISH MINES AND CORNISH MINERS.

By J. H. COLLINS., F.G.S.

Preliminary. — The West of England mining district comprises the whole of Cornwall, and the western part of Devon, which is, geologically, mineralogically, and to a large extent racially, one. For the purposes of this paper, it will all be spoken of as Cornwall, and its men as Cornishmen.

Geological Outline.—The geological structure of Cornwall is well known; a series of stratified rocks, mainly of Palæozoic age, has been pierced and penetrated by granitic rocks of various periods and at many points, and afterwards extensively fissured. In these fissures, which may be numbered by thousands, various kinds of ores have been deposited, and especially the ores of tin and copper. Subsequent denudation of the area, to the extent of thousands of feet, has laid bare, so to speak, the roots of the mountains, and so brought these mineral lodes within the reach of the miner, and furnished the materials of the stanniferous valley gravels. In the formation of these lodes the granitic intrusions have played a predominant part, for although it cannot be said that all the metallic minerals have been brought into the vein-fissures by

their agency, or that all the granite junctions are metalliferous, yet it is certain that more than half the valuable ore deposits have been found within a few hundred yards of such junctions, and within what St. Claire Deville called "the granitic penumbra" of altered rocks.

Antiquity of Tin Mining.—There are few who realise that mining in Cornwall has been carried on for more than 3,000, if not more than 4,000 years, and that the tin required for fixing the colours of the scarlet curtains of the Hebrew tabernacle, and in making the "brass" for Solomon's temple, as well as that used for the bronze weapons of Homer's heroes, was pretty certainly derived from the gravels of our West country valleys. We have abundant evidence that tin was not only mined but smelted in Cornwall, and, while there is every probability that some of it was shipped from St. Michael's Mount more than 3,000 years ago, it is certain that another portion was shipped from Falmouth, for one of the peculiarly-shaped blocks, exactly of the "knuckle-bone" form described by ("'αστραγαλων") Diodorus Siculus (lib. v., c. 9), was long ago dredged up in Falmouth harbour, and is now in the Truro Museum. Having given the subject much consideration I do not see how anyone can reasonably doubt that the conclusions set forth many years ago by Dr. Barham, and afterwards by Sir Henry James, also by Dr. George Smith in his most interesting book called the "Cassiterides," and by the late Mr. R. N. Worth in his "Antiquity of Mining in the West of England," are substantially correct, and that the Phœnicians traded for tin in the West of England with the inhabitants of a group of supposed islands, long before Solomon's temple was built.

The Valley Gravels.—No doubt these were the first to be worked for tin. Most of the granite moors and many of the valleys coming down from the moors have afforded abundant indications of these early works, some of which continued to be wrought down to our own times; indeed, I am not sure but there are still some veritable "streamers" at work each winter on the flanks of Helmen Tor, and on the Bodmin moors, as well as on the moors to the west of Penzance. The West country museums contain many most interesting relics of those early stream works, as also of the early smelting works, especially from Tremethick moor, Marazion, and the Carnon and Pentewan valleys; the transactions of the Western scientific societies are replete with valuable pap[ers] on the same subject, among which I may pa[r]ticularly mention those by my old friend, t[he] late Wm. Jory Henwood.

Submarine Tin-gravels.—The lower p[or]tions of several most important tin-beari[ng] valleys have been submerged to considerab[le] depths since the gravels were first formed, [so] that the tin is still lying far below low-wat[er] mark. There may be some here who w[ill] remember the visit of the Institution of M[e]chanical Engineers to Cornwall, in 1873, wh[en] they examined the interesting tin-gravels th[en] being worked by Messrs. John Taylor a[nd] Sons, under the waters of Restronguet creek.

The "Old Men."—We owe much to t[he] early streamers, known as the "ancients" [or] "the old men," for they were the discovere[rs] of nearly all the lodes which have been [so] extensively worked in Cornwall during the la[st] seven or eight centuries. The best of all wa[ys] of discovering a lode, from a miner's point [of] view, is to remove all the surface soil and loo[se] material, so as to lay bare the solid rock, t[he] "shelf" as it is called by the tinner. A[nd] this is what "streaming" is sure to do. Thu[s], also, the tin deposits known as stock-work[s] were discovered. These were quarried ou[t] and the "backs" of lodes were worked aw[ay] until the water flowing into the excavation[s], even in dry seasons, became too great to b[e] dealt with by the rude appliances of ancie[nt] times; adits were then driven into the hil[l]sides for the sake of the "backs" of t[he] ground thus drained, and bit by bit the ide[a] of the shaft formed in the mind of the worke[r], and was practically carried into effect.

Copper and Other Minerals.—These we[re] no doubt discovered while working for tin. A[t] first supposed to be worthless or even found t[o] be very injurious to the smelted tin, such ore[s] were carefully avoided—left behind in the work[]ings, or thrown away. But uses were graduall[y] found for the rejected copper, at first by the pre[]historic hunters and warriors who discovere[d] the merits of bronze and the methods of pro[]ducing and working it; afterwards uses for th[e] other minerals were found by chemists an[d] manufacturers. They were diligently sough[t] for, and so it has come about that almost ever[y] metallic mineral of importance in the arts, except platinum and quicksilver, has bee[n] obtained from the West of England mine[s] during the past two centuries.*

* I may here recall the interesting fact that, in 175[] the Society of Arts awarded a premium of £30 for the be[st] cobalt found in England to Mr. Beauchamp, who found som[e]

ill, it may be said that the only metallic erals that have been produced on a large e and for lengthened periods are tin and per. For comparatively brief periods mines ead, antimony, zinc, iron, or manganese, been worked at a profit; while ores of el, cobalt, uranium, bismuth, tungsten, and r more or less rare metals, have usually saleable when met with, though very ly in themselves remunerative. Lately nic has been in demand, and that grand group of mines, the Devon Great Consols Tavistock, has given many substantial dends as the result of working great bodies rsenical pyrites, formerly left behind in the

he Precious Metals.—It has been suged that the West of England only needs e properly prospected to discover payable osits of gold and silver. It is, of course, known that gold has been found in minute ntities in all the stream works; that conrable bodies of rich silver ores have been with in several of the mines; and that gold and silver in small proportions exist ost universally in the copper ores. I am the miners have often suffered from their rance of this latter fact, and from their ect to have the ores fully analysed. I well ember Mr. Charles Fox, of Falmouth, tellne that he knew of a mine in the east of wall from whose ores the smelters had cted £60,000 worth of silver for which had never paid the miner one penny, and, ss I am greatly mistaken, I could give you ame of the mine, and also of the smelter. ever, with a knowledge of these facts, I still bound to say that I see no reason xpect that either a paying gold mine paying silver mine will be found in the t of England. It is, at any rate certain the whole precious metal yield of the West ngland, past and present, has not equalled ields respectively of a single gold or silver of the first rank for a single year. On whole, I think it will be admitted that, with exceptions, the only ores that have been tably and extensively worked in the district ny lengthened period are those of tin and er, although for a short time lead ores of considerable importance.

rogress of Mining.—A mere sketch of the ress of mining in the West of England d occupy more time than we have at our disposal this evening. But I may perhaps venture to set up a few land-marks, referring you to the transactions of the local scientific societies for many others.

Deep Mining.—I have already referred to the evidence existing elsewhere, which shows that tin-streaming is at least 3,000, and probably 4,000 years old, while tin-mining in a strictly accurate sense of the term, *i.e.*, underground mining, dates at least from the 15th century, and is probably much older.* When Carew wrote, at the end of the 16th century, there were already several mines more than 50 fathoms deep. Copper mines "more than 60 fathoms in depth" are also referred to so far back as 1678, and Tonkin, writing in 1733, speaks of "Puldyce in Wennap" (*i.e.*, Poldice in Gwennap) as being over 100 fathoms deep, and supplied with regular ladder-ways; a remarkable depth to be reached without wire ropes, and before Watt had improved the steam-engine. The Cornish mines were then the deepest in the world. We have now attained a depth more than four times as great, but we no longer have the pre-eminence in this respect, for there are many mines in many different countries which very largely exceed the present depth of Dolcoath, now our deepest mine. It must, of course, be admitted that, in shaft-sinking, Cornwall does not at present stand in the first rank. There are, indeed, special reasons why the very finest shafts should not be found in connection with vein-mining, which I will not further refer to at present. Yet there are many good shafts in the county, and I can say that many of the best shafts ever sunk in the United States, in the Transvaal, and elsewhere, have been sunk by Cornishmen, while the Cornish systems of stoping and timbering are almost universally adopted in vein-mining. It is right to say, however, that these methods, as well as the use of gunpowder, appear to have been introduced from Germany in the reign of Queen Anne.

Pumping Machinery.—As already intimated, tin ores have often been worked downwards, right from surface, but, with a few exceptions, among which may be mentioned Wheal Virgin in Gwennap (first discovered in 1757), and Wheal Maria near Tavistock, which was discovered in 1844, valuable and extensive deposits of copper ore have not been found far above the natural "drainage-level" of the country, *i.e.*, the depth at which some system of artificial drainage becomes necessary.

vennap parish associated with bismuth, which latter ance was thrown away until Dr. Herbert Schlosser a method of separating and utilising both in the year

* See "Seven Centuries of Tin-Production." "Trans. Min. Assoc. and Inst.," 1892.

The development of copper-mining into one of our great industries may, therefore, be considered to have begun with the employment of powerful pumping engines.

Some of the early pumping engines were worked by water power, but this is by no means so generally available in the West of England* as many people imagine, so that until steam power was employed, many of the best mines remained unworked. Mr. Carne† states that the first steam-engine employed in Cornwall for pumping was erected at Wheal Vor, a famous tin mine in Breage, which was extensively worked between the years 1710 and 1714, as well as long before and long after. He considers it doubtful whether the engine was on the plan of Savory or that of Newcomen. It might well have been the latter, as Newcomen's patent was granted in 1705. Dr. Borlase mentions the existence of "fire-engines" in his time at no fewer than eleven mines, of which six were copper mines. Some of these—probably all—were on Newcomen's system, and some were very large; thus the engine at Herland mine had a cylinder of 70 inches diameter.

The employment of these great engines alone rendered it possible to work the mines, which were often very wet; and, at the same time, the fact that they were so employed is strong evidence of the importance to which copper mining had then attained.

Duty of Cornish Engines.—The subsequent improvements in the Cornish pumping-engines, which were effected by Watt; and those of the boilers, which were carried out by Trevithick—followed up by the minor inventions of Woolf and Husband, and combined with the admirable Cornish system of pit work, enabled our engineers, in spite of crooked shafts and bad water for the boilers, to reach a degree of perfection 50 years ago which, all things considered, has never been exceeded. When I tell you that they were able to raise a ton of water 450 feet high by means of the steam produced by burning only one pound of coal, and at a cost of about half a farthing, you will appreciate that fact. At present the duty is not much more than half of what was at one time "reported" for the best engines, such as those employed at the United Mines in Gwennap, and at Fowey Consols, near Par, and the reason for such falling off is often asked. It is not so much that the engines, though generally old, are absolutely worn c ; in fact, it is one of the merits of a Corn pumping-engine that even when 100 years it will often do better work than a new eng of another and less perfect type. But t often have to work through old and croo shafts, fitted with leaky or choked pu columns, and balancing arrangements wh are so worn that they are scarcely capable f being kept in proper order, and the boilers too often old and worn out. The result is t the "duty" is often far behind that realised the great waterworks, though Cornwall raises its water more cheaply than m mining regions which are thought to be a-head of her in all respects.

Winding Apparatus.—If Cornwall s taken the lead in pumping large quantities f water from great depths at small cost, it c not claim equal merit for the greater part of winding apparatus employed even in the lar mines, for the West-country methods have b improved upon greatly in almost every c mine as well as in all the larger foreign m mines. Yet Hayle foundry has turned out, still turns out, some of the finest engines made, while Mr. Stephens, of Ashfield, n Falmouth, was among the first to make ro of wire. The Cornish miners too were qu to use them, indeed without these ropes would have remained quite impossible to r ore from deep mines except by a co system of separate stages. Incidentally, t this invention has led to the supercession f the Fahrkunst or "man-engine," the in duction of which the Royal Cornwall P technic Society did so much to encourage years ago, when the first Cornish man-engine was erected at Tresavean Mine.

Ore-dressing, &c.—In the West of E land, as in other countries, only the richer were worked in the earlier days of mining, it was in time found that many of the mi were capable of yielding large quantities of grade "dredgy" ores in which small parti of the tin and copper ores sought were as ciated with much larger quantities of pyrites, arsenical pyrites, and other meta substances, together with quartz, felspar, m schorl, chlorite, and other earthy compone As regards tin, stamping was a very e method adopted for freeing such ore parti from the waste, so as to obtain a market product; and supplemented by calcining fine grinding, this has continued to be method almost exclusively employed up to present. But in the case of copper ore

* It has, however, been extensively employed at Devon Great Consols for more than fifty years.

† "Trans. R.G S.C.," iii., p. 60.

oon found that stamping entailed a very loss, so that a system of breaking with ners, called "bucking" and "cobbing," ed by jigging in a hand-sieve, was ed, as it had been a long time before in ad mines in the north of England. And ater, when a difficulty was experienced in g a sufficient number of "bal-maidens" uck" the large quantities of dredge ore l at Wheal Friendship, Mr. John Taylor ted the method of crushing by means of olls. I have heard the late Mr. Richard r say that the first rolls were made by g up a large "pump" and filling the s with wooden blocks, in which were fixed xles on which they revolved. The jigging was replaced by the well-known brake-jig, this by Collom's and a great many forms of continuous jigger, which made sible to deal with very large quantities of rade ore hitherto valueless. Much of re could not be dressed up to any very produce, yet the cheapness of the process such that it is likely the profits were, vely larger on the low grade than on icher ores. The gradual fall in the duce" of the Cornish copper ores is very eable. Thus :—

1771,	the	produce	was	12·0	per cent.
1800,	,,	,,	,,	9·6	,,
1801-10,	,,	,,	,,	9·0	,,
1811-20,	,,	,,	,,	8·5	,,
1821-30,	,,	,,	,,	8·0	,,
1831-37,	,,	,,	,,	8·125	,,
1848-50,	,,	,,	,,	7·5	,,
1851-60,	,,	,,	,,	7·0	,,
1861-90,	,,	,,	,,	6·5	,,

highest price (of ore) of which we have record (Jan. 1765) is £60 per ton, the st price, *at the same date*, was £1 10s. on, while the average of four centuries been about £6 per ton.

tin dressing generally, I do not hesi-to say that, considering the peculiar con-ns of climate and wages, and of the work done, the simple, cheap, and easily re-d common gravitation stamp, the plain d buddle, the Stephen-Toy grinder, the ving table, the self-acting dead frame, the wheel elevator, leave very little room nprovement. I doubt whether they will ever enerally superseded by the more expensive ornian stamps and the Frue-vanners which been so largely and successfully employed r quite other conditions in gold-mining; act, I believe that in this department of tin-dressing Cornwall has very little to learn from any part of the world.

Boring-machines.—The Cornish were among the first to employ boring-machines in mining, and my friend Prof. Le Neve Foster, the son of your former able secretary, was one of the persons concerned in their introduction in the year 1866, when experimental trials were conducted at Falmouth under the auspices of the Royal Cornwall Polytechnic Society and the Miners' Association, he being at that time secretary of both societies. Soon after this, Mr. Doering made his first contract for machine boring in Tincroft Mine, where I saw his machines at work early in 1868. At that time steam was used as the motive force, now compressed air is almost invariably used, to the great advantage of the ventilation. The first machines were all, I believe, made abroad, in France, Germany, Sweden, and the United States, but Cornwall now builds machines for mining purposes, which are at least equal to any that the world can produce.

Safety Fuse and High Explosives.—Cornwall was also very early in this field. The safety-fuse of Bickford, Smith and Co. has long been known wherever mining is carried on, and has undoubtedly been the means of saving hundreds and even thousands of valuable lives. The use of high explosives, with their superior economy and safety, for many kinds of work followed immediately on the introduction of the boring-machine. Many of the early experiments and trials were promoted by the local societies already mentioned, as their reports for over a quarter of a century abundantly show.

Cheap and Effective Working.—It is not generally known how very cheaply work is done in Cornwall when the conditions are favourable. Let me give you an instance which has come under my own notice. At Great Wheal Fortune, in Breage, is an ancient tin-stockwork, which is now worked by open quarrying. In the five years 1893-8 some 35,000 tons of stuff were treated from this quarry, of which one-half was broken down from the solid, while the other half was already broken. The stuff was selected into one-third waste and two-thirds ore. The whole was loaded into waggons, trammed to an average distance of 300 yards, the one-third waste tipped over the dump, the two-thirds ore tipped into stamps or jiggers, crushed, and dressed for sale. I will not now trouble you with the details of the expenditure, but the total cost, including local supervision, but ex-

cluding management expenses, which were trifling, was only very slightly over one shilling per ton.

It is right to say that the rock broken was soft and slaty, and very full of joints, so that very little blasting was required; also that the stamps and jiggers are worked by water-power. I doubt whether this record has been broken anywhere, but I could mention many places where it has been nearly equalled.

Were the quantities dealt with, the supply of water for power and ore-dressing purposes and the tipping-ground all largely increased; and were there large funds available for the erection of a more modern plant, which is not the case, even then I am persuaded the cost of the work could not be lessened materially.

So much for open-quarrying and water-power. I will now give an illustration from the deepest and one of the wettest mines in Cornwall, where only steam-power is available, and where the ground is excessively hard. I refer to Dolcoath Mine.

In the last six months of 1898 there were broken, raised from an average depth of nearly 2,000 ft., crushed and dressed, over 40,000 tons of stuff at a cost of £41,000, just over £1 per ton, or, excluding royalties, 19s. per ton. It is not easy to find a case elsewhere which runs quite on all fours with Dolcoath; but, taking all the conditions favourable and unfavourable into account, I doubt whether much cheaper work is done anywhere.

Peculiarities of Lode Mining.—This is not meant for a technical lecture, and I do not propose to say much about the peculiarities of the lodes, which yield the greater part of the metallic wealth of the West of England, nor yet with the methods of working usually adopted. Yet it may be well to touch briefly upon both these subjects. And, first, let me try to give you an idea of one of our great tin-lodes—that which has for so long been worked in Dolcoath, Cook's Kitchen, Tincroft, and Carn Brea Mines.

I shall speak by-and-by of the enormous riches of this lode—yet if we look at the facts in another way (as suggested by M. Moissenet), we shall see how insignificant a feature it forms in the earth's crust. Let us suppose a model of the lode made to a scale of one-thousandth the real size—it could be easily made from a sheet of lead 12 feet long and 3 feet wide. In many places the thickness would have to be reduced to a mere film, but in some it would require to be thickened up to a quarter of an inch or a little more. The sheet might be placed on edge, its length in a d[irec]tion nearly N.E., S.W., and with a cons[ider]able dip to the southward. If now it were [bent] lengthwise, in such a way that the th[icker] portions stand more nearly vertical than [the] thinner, and the lower portions more n[early] horizontal than the upper, it would very [fairly] represent the relative proportions of the [lode] and also its position in the ground. "Vi[ewed] in this manner, the vast and richly-filled [sub]terranean channels, which by the implen[ents] of the miner are transformed into caver[ns of] imposing extent, appear what they are—as [thin] veins in the ground."

The ordinary method of working such a [lode] may be easily understood by reference t[o the] plan and section of the old Tolcarne M[ine] which has been lent to me by Mr. Wi[lliam] Thomas, of Camborne, and still bette[r by] the fine section of Levant Mine, for whi[ch I] am indebted to Messrs. Henderson and [Son] of Truro, and in particular to their assi[stant] and former pupil, Mr. E. Maxwell-Lefroy, [who] has surveyed most of the ground and mad[e the] plans shown. This is a very ancient mine, [and] it has been worked both for tin and coppe[r for] three-quarters of a mile beneath the Atl[antic] Ocean. You will see that a main shaf[t has] been sunk near the shore in the lode i[tself] and following its inclination. From this [the] levels have been driven along the [lode] usually 10 fathoms or 60 feet apart, [and] finally the richer parts of the lode have [been] stripped away between the levels. The w[aste] and the ore-stuff are both raised to the su[rface] by powerful steam machinery working thr[ough] the main shaft, and on reaching the su[rface] the ore is crushed and dressed until it is fi[t for] the market.

Levant is not the only mine which has [been] worked under the sea. The ores at Botall[ack,] Wheal Cock, and many other mines in W[est] Cornwall, have been followed beyond the s[hore] line for considerable distances, though n[ot so] far as in the case of Levant.

Besides the metallic minerals wrought i[n the] West of England, there are other impo[rtant] mineral substances, such as china clay,* c[hina] stone, potter's clay, and granite, of w[hich] 897,793 tons were raised in the year 1896[, the] value at the pits being £415,677. Wit[hout] referring further to this part of the Co[unty]

* A lecture on the china-clay industry was given [by the] present author in this room in the year 1875. Since th[at time the] industry has been very greatly extended, but very fe[w new] discoveries have been made, or methods adopted sinc[e that] time.

ral industry, I will now briefly review the se of our great tin and copper industries.

n Production.—It has already been stated tin mining has been carried on in Cornwall hree, and perhaps for four, thousand years, I have elsewhere given* some reasons for ving that the "black tin" produced in West of England, from pre-historic times to the end of the 12th century, could have been less than 350,000 to 400,000 , or, say 250,000 tons of "white" or allic tin.

he first historical notices of tin production from the reign of King John (1199 to 6), when the tin revenues of Cornwall and on were farmed for £266 13s. 4d. per um, from which amount we may infer with air degree of probability† that the annual duction of white tin in the two counties was very much over 100 tons. A century later quantity had risen to about 400 tons for nwall, and perhaps half as much for Devon. vards the close of the 14th century the ntity had somewhat fallen off, and it seems ave remained at between 400 and 600 tons annum for the two counties, up to the end he 16th century, and at least a dozen years o the 17th. Delabeche says:—"In the gns of James I. and Charles I., the two nties are said to have raised together from oo to 1,600 tons per annum, but this could y have been in years of maximum produce was only about 500 tons in 1611)." On the ole, and for reasons given,‡ it would not be fe to reckon more than an average of 1,050 s for the first 40 years of the 17th century.

In Charles II.'s reign the revenue is stated have been "small," but under Queen Anne d George I. the annual output is stated to ve exceeded 1,600 tons, so that for the riod 1650-1725 we may probably reckon th safety an annual average of 1,400 tons.

In 1742 the average produce of Cornwall one for several years is stated at 2,100 tons, d adding, say, 50 tons for Devon yearly (for this time the productions of Devon had ased to be important), we may reckon an verage of 2,150 tons for the second quarter of e century. From 1750-1779, the average for ornwall was 3,000 tons, or, again adding 50 r Devon, 3,050 tons for the two counties. rom 1780-1799, Cornwall produced each year 3,377 tons, and, again adding for Devon 50, we get a total of 3,427 tons.

All the above figures are for "white" tin, *i.e.*, metallic tin. From the beginning of the present century we have the figures for black tin, *i.e.*, dressed tin ore fit for the smelter.

The following are the figures for the two counties (Devon being only a contributor to the extent of about 50 tons per annum) for decennial periods; partly calculated from the figures given by Delabeche, and partly from the mineral statistics of Mr. Robert Hunt and his successors:—

Black Tin.

	Tons.
1800-1809	4,294
1810-1819	4,650
1820-1829	6,344
1830-1839	5,840
1840-1849	8,912

Mean of 50 years, 6,008 tons; total, 300,400.

1850-1859	9,535
1860-1869	12,585
1870-1879	13,513
1880-1889	13,480

Mean of 40 years, 12,278 tons; total, 491,130.

1890	14,911
1891	14,488
1892	14,357
1893	13,689
1894	12,910
1895	10,612
1896	7,663
1897	7,120

Mean for 8 years, 11,969 tons; total, 95,750.

The remarkable increase during the second half of the 19th century took place in the face of very large competing supplies from Australia, Tasmania, the Dutch East Indies, and the Straits Settlements. The supplies from the last-mentioned source, however, have been so much greater during the last few decades, and, following the depression of silver, have been profitably sold at such low prices, that the West of England production has lately shown a serious decline, owing to the closing of nearly all the mines except those in the neighbourhood of Camborne, while even the rich Camborne mines have been worked for the most part for several years at a loss.

From the best sources at my disposal I am inclined to think that the following generalised Table gives figures of the production which are not very far from the truth:—

* "Origin and Development of Ore Deposits." "Journ. oy. Inst," Cornwall, xi., 1895.
† "Seven Centuries," &c., 1892.
‡ "Seven Centuries," *passim*.

	Per annum. White tin. tons.	Per annum. Black tin. tons.
13th century......	300	461
14th ,, ...	538	828
15th ,, ...	476	732
16th ,, ...	526	809
17th ,, ...	1,170	1,800
18th ,, ...	2,560	3,938
19th ,, ...	5,737	8,857

A number of interesting enquiries are suggested by these figures, as for instance, the reasons of the remarkable "leaps and bounds" in the production; the proportions of tin yielded respectively by "stream works," "stock works," "backs of lodes," or "coffin lodes," used by true underground mining; as well as the relative proportions yielded by West Cornwall, East Cornwall, and Devon.

A remarkable increase of production is noticeable towards the end of the 14th and the beginning of the 15th century, and this may have been occasioned by the great demand for bell-metal from which to cast the innumerable church bells required for the many churches built after the Wars of the Roses were ended. Good bell-metal contains about 20 per cent. of tin, and the quantity required at that period must have been very great.

A second period of especially rapid advance —the latter part of the 18th century—is that of the common use of bronze for artillery. The third period arose within our own recollection, and may be known as the "tinned meats" period. As to the ratio between the quantities of "stream-tin" and "mine-tin," there are very few and no exact statistics available until near the middle of the 19th century, by which time the proportion of stream-tin had fallen to about 2 per cent. of the whole. We know, of course, that in the two or three thousand years of working before the time of King John, the production must have been almost, if not exclusively, from the gravels; and so it must have been for some centuries after that reign. But there were some mines as much as 50 fathoms deep in Carew's time (towards the end of the 16th century), among which we may doubtless reckon Wheal Vor and perhaps Polgooth and Botallack, although these were not likely to be large producers at that time. No doubt, too, the backs of many other lodes were being worked in the 16th, and even in the 15th centuries, as well as such stock works as Carclaze, Minear Downs, Gover, and Great Wheal Fortune. But, on the whole, we are not likely to be far wrong if we look to the valley gravels as the source of the bulk of tin raised up to the end of the 18th century

It is most unlikely that all the mines n tioned were worked simultaneously. On whole, I do not think we shall under-estin the mine product of black tin if we put 1,394,500 out of the total of 1,742,500 raised during the past seven centuries.†

As to the previous 20 or 30 centuries, ge rally, so far as we have any evidence of relative production of the two counties, it wo appear that Devon has only produced ab 6 per cent., as compared with Cornwall's 94 cent.‡

I call special attention to this fact, beca several writers have commented on enormous extent of the ancient workings Devon, and have speculated upon la populations supposed to have been form engaged in tin mining in and around D moor.

As regards Cornwall itself, it is certain t the western part, from the Carnon Valley the Land's End, has produced greatly m tin than all the rest of the county tak altogether, and that the flanks of Carn B Hill have, so far, been the most product part even of West Cornwall, although v great riches have been obtained from the Ives, Land's End, and Breage districts, neit of which is in any sense worked out.

Of individual tin mines many are known have been large producers, and to have yield large profits before there were any offic

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* Many of these were no doubt worked out when Henwood wrote of them in the first half of the 19th cent See, however, the long list referred to by him in 1873 in Presidential Address to the Royal Institution of Cornw At the close of the 16th century there could not have b more than from 12 to 20 mines proper producing tin, Balnoon, Botallack, Balleswidden, Wheal Reeth, Gr Work, Wheal Vor, Polgooth, Bucklers, Beam Bunny, C claze, Polberro, and Wheal Kind are pretty nearly all of wh we have distinct evidence in West and Central Cornwall up the middle of the 18th century, with Drakewalls in East Co wall, but it is probable that we might add to this list ot open works than those already mentioned, as Wheal Grey Breage, Mulberry and Wheal Prosper in Lanivet, Wh Whisper in Warleggan, Great Treveddoe, in St Neot, a some others on the borders of Dartmoor.

	Mines.	Streams.	Total.
† 13th century ...	5,000 ...	41,100 ...	46,100
14th ,, ...	10,000 ...	72,800 ...	82,800
15th ,, ...	20,000 ...	53,200 ...	73,200
16th ,, ...	30,000 ...	50,900 ...	80,900
17th ,, ...	135,000 ...	45,000 ...	180,000
18th ,, ...	338,800 ...	55,000 ...	393,800
19th ,, ...	855,700 ...	30,000 ...	885,700
	1,394,500	348,000	1,742,500

See also "Seven Centuries, &c." pp. 180-182.

‡ *Ibid*, p. 183.

stics published. The following may be cularly mentioned:—Balleswidden, Botal- . Levant, St. Ives Consols, Great Work, aunance, Wheal Kind, Providence, Ding g, Wherry, Wheal Vor, Great Beam, ilers, &c. In more recent times, besides ral of those just mentioned, the following been, and some still are, very profitable:— al Metal, Dolcoath, Carn Brea, Tincroft, Pool, Wheal Eliza, &c.

opper Production.—Up to the year 1700 likely that a great deal of the copper ined had been got while working for tin, about that time more systematic opera- s appear to have been commenced. It is bable, too, that up to that time most of the es were either open works or comparatively llow mines, drained by means of adit ls, although "the pits sometimes exceeded athoms in depth," so far back as 1678.

n 1729 we are told that North Molton Mine, Devon, was at work, and raising ores which l for £6 10s. per ton, and Tonkin, writing 733*, mentions Wheal Rose in St. Agnes, wan Downs, and Trevascus in Gwinear, as per mines then working. Pryce mentions t in 1737 there were raised in Cornwall he no less than 9,000 tons of ore; a greater duction than the present, by far, if we take account the greater richness of the ores in se days.

n the period from 1718 to 1758, Borlase ntions the following as the most profitable pper mines:—Chacewater in Kenwyn (after- rds known as Wheal Busy), North Downs Redruth, Huel Rös in St. Agnes, Roskear, el Kitty, Dolcoath, Bullen Garden, Entral l Longclose in Camborne, Huel Fortune in dgvan, Huel Virgin, Metal Works and Tre- vyan (Tresavean) in Gwennap, Binner wns, Herland and Clowance Downs in inear, Huel Cock and Rosmorran in St. st. He remarks that very few copper mines ve much profit until near the end of the h century. Towards the end of the century, d especially in and around Gwennap parish, e mines already at work were in many cases eatly extended, so that the six ore-purchasing mpanies of 1751 had increased to thirteen the year 1778.

Wheal Virgin, in Gwennap, was discovered the year 1757. The ore "made" quite near e surface, and according to Borlase, the ine produced in the first fortnight ore which sold for £5,700 at a cost of £100. In the next three weeks and two days ore was obtained which sold for £9,600 at a slightly increased proportional cost. No other such great and sudden discovery as this was made for near 100 years; but, besides most of the mines already mentioned, there were many others of importance, among which may be mentioned the Carharrack mine, Wheal Lovelace, East Wheal Virgin, West Virgin, and Wheal Fortune (afterward worked extensively as the Consolidated Mines), Ting Tang, Wheal Squire, Poldroy, Ale and Cakes, East Ale and Cakes, and Wheal Friendship (afterwards worked together as the United Mines), Wheal Chance, and many others.

The first great collapse of copper mining.—Before the end of the 18th century, besides the mines just named, Dolcoath, Cook's Kitchen, the Pool Mine, and many others in Camborne and Illogan, as well as some in Redruth and St. Agnes, had become important copper producers. Dolcoath itself, now including Bullen Garden, and sunk to a depth of 160 fathoms, had already yielded ores worth £2,000,000 before the end of 1778. Several mines in Devonshire were also producing important quantities of ore, Wheal Friendship in particular being both extensive and profitable. But the West Country mines received a very heavy blow by means of the great discovery of copper at Pary's Mountain in 1772, and the consequent heavy fall in the price. Watt, writing to his partner, Boulton, in 1785, gives a very dismal picture of the principal mines, and in particular of the Chacewater Mine (Wheal Busy), Poldice, Wheal Chance, the Pool Mine, Roskear, the United Mines, Wheal Union, and Cook's Kitchen. Owing to the increasing depth of these mines, and to the inadequacy of their pumping machinery, they were unable to compete with the Anglesey mines. Several of the largest were abandoned, but others struggled on in hope of better times, and at length the better times came. The introduction of Watt's improvements in engines, and the improved price of copper following on the stoppage of the Pary's Mountain in 1792, gave some of the mines, and especially Dolcoath, a new lease of life, and the last year of the century saw copper selling at £128 per ton.

The Great Revival.—Counting small and great, there were at the beginning of the present century 45 mines working for copper alone in Cornwall, besides 18 working for copper and tin, one for copper and silver, and one

* See "Four Centuries of Copper Mining." "Trans. . A. and I. of Corn," 1894-5.

for copper and cobalt. In Devon there were 10 copper mines at work, but these were all of small importance at this time. The following were the leading mines at the various periods mentioned :—

1800. Wheal Alfred and Dolcoath were the largest producers. The former employed 1,500 people. It continued working until 1831, and, as Wheal Alfred Consols, until 1856. Dolcoath at this time was just beginning its second period of prosperity. Other important mines about this time were Wheal Unity, Wheal Damsel, Wheal Virgin, the United Mines, Treskerby, Cook's Kitchen, Tincroft, Oatfield (Crenver), and Godolphin. These were all large producers, but not all very profitable.

1815. Dolcoath had now the leading position, its ores selling this year for £66,839. It continued to produce copper largely until 1846, the mine being then 210 fathoms deep, but only drained to the 160. Other productive mines at this time were Crinnis, Wheal Alfred, Wheal Unity, the United Mines, Wheal Damsel, Treskerby, Wheal Abraham, Wheal Towan, and Gunnis lake, but only the first two mentioned were at this time profitable.

In 1814 the costs at Wheal Alfred were £1,000 per month, and at Crinnis £2,000 per month. Tresavean now began to be an important producer.

1817. The United Mines had now reached the first place, its ores selling for £63,116.

1822. The Consolidated Mines, only recently reopened, sold ores to the amount of £80,311. Fowey Consols now began to yield largely, and Great Wheal Busy (the old Chacewater Mine), Wheal Baller, Wheal Beauchamp, Binner Downs, and other large producers were beginning to affect the market.

1827. In this year the Consolidated Mines gave 13,487 tons of ore, Penstruthal 12,078 tons, and 18 other mines, all in Gwennap, raised the produce of that parish alone to a total of 46,809 tons.

1838. By this time there were, according to Sir Henry Delabeche, over 76 mines producing copper in Cornwall, besides several in Devon. The three largest producers were now the Consolidated Mines, which sold 19,489 tons of ore for £126,211 ; Fowey Consols came next with 15,254 tons for £85,435 ; and Tresavean followed with 12,303 realising £76,272. This latter mine—one of the oldest copper mines in Cornwall—had been a very large producer ever since 1829. At this time there were, besides those mentioned, above 30 other mines in Cornwall, each producing over 1,000 tons of ore per annum. The prices ranged from £18 11s. 6d. per ton at Botallack, and £12 12s. at Levant, down to £2 4s. 6d. at Wheal Burrow ; the average price being £5 17s. 6d. per ton.

1842. This year Tresavean was the leading mine. From a return made at this time it appeared that from June, 1834, to June, 1842, it had yielded over 99,000 tons of ore, realising £610,893. The same return showed that the average annual profit from 1838 to 1843 was £30,693, and the average number of people employed about the mines was 1,300.

1845. In this year the great discovery at Wheal Maria, near Tavistock, which had been made in the previous year, began to tell on the market. Devon Great Consols, which besides Wheal Maria, included Wheal Fanny, Wheal Josiah, and other mines, at once took the leading position among the West Country copper mines, and, with a few short periods of exception, has held it ever since.

1850. In the 50 years from 1801 to 1850, 5 mines in Cornwall, and 3 mines in Devon sold ores realising over £13,000,000 sterling, the Consolidated Mines in Gwennap leading with near £2,000,000 ; the United Mines coming next with about £1,500,000 ; Devon Consols, Dolcoath, Fowey Consols, and Tresavean, each contributing over £1,000,000 ; and the remainder falling in with amounts varying from about £700,000, in the case of Wheal Friendship, in Devon, down to about £100,000 for several others. Besides these, there were of course, many smaller mines.

The Culmination (1851-1860).—This period of ten years witnessed the culmination of Cornish copper mining, as well as the commencement of its decline. In 1853 there were 98, and in 1859 no fewer than 170 mines producing copper ore in Cornwall and Devon, the chief producers being Devon Consols, Fowey Consols, and the new and rich mines then recently discovered in the Caradon district. In the year 1856, Messrs. Phillips and Darlington published a list of 76 mines which had each up to that time sold over £100,000 worth of ore since the beginning of the century, and of 107 more which had sold between £10,000 and £100,000 worth. In Cornwall copper mining reached its actual high-water mark in 1855, when 161,576 tons of ore were sold for £1,064,474. Next year Devon reached its highest output with 42,024 tons, which sold for £215,644 ; but the highest value was attained in 1857, when 37,800 tons sold for £222,416.

The Decline.—This, at first, was not ve

, but its progress was soon accelerated, ll appear from what follows :—

;9. There were at this time 102 mines ıcing copper, 84 in Cornwall, and 18 in n. Of these, Devon Consols came first 15,988 tons, Clifford Amalgamated fol- l with 7,579 tons, West Seton, Marke y, and South Caradon, each produced 6,000 tons, and there were six others e output exceeded 1,000 tons each.

74. The number had now fallen to 92 (78 in wall, and 14 in Devon), Devon Consols ng first with 5,694 tons, Marke Valley ving with 4,325, and twelve others with rds of 1,000 tons each.

79. The copper-producing mines were 47 (40 in Cornwall, and 7 in Devon), n Consols led with 10,261 tons, then came anear with 6,528, and South Caradon with . Seven others produced each over 1,000

84. Devon Consols still led with 10,420 followed by Mellanear with 6,928, South don 4,096, Wheal Crebor 2,924, and Bed- United 2,311. Four other mines produced between 1,000 and 2,000 tons.

86. There were now only three mines pro- ng over 1,000 tons, Devon Consols coming with 6,077, Mellanear next with 4,019, and al Crebor, 2,562. The whole copper pro- ion of the two western counties was now elow the production of several individual s in the middle of the century.

87. The diminution still continued, only mines rising above the 1,000 tons output on Consols 4,209, Mellanear 1,939).

88. The production rose a little, as Devon ols yielded 4,784 tons, Mellanear 2,857, al Crebor 1,286, and Levant 1,209.

89. This year again showed a serious ne, less than 8,000 tons of ore having been d, and this of very low grade for the most yielding in all less than 700 tons of fine er. To meet with such a small quantity rmer years we must go back to the end of 7th century. Levant took the first place e year with 1,505 tons of ore, and was wed by Wheal Crebor and three other s, each with over 1,000 tons. Devon Con- sold very little ore during the year, so g the leading position which it had held ng so many years.

90. This year saw a little improvement, nt taking first place with 1,979 tons, sold £6,798. Devon Consols followed with 8 tons of very low grade ore, sold for 10, and was followed by Callington United, which sold 1,417 tons for £4,055. The total production of the West of England this year was 11,309 tons, worth £24,498, or only about two guineas per ton. Since 1890 the production has been as follows :—

Date.	Tons.	Value.
1891	8,329	£17,924
1892	5,631	10,601
1893	5,144	12,540
1894	5,676	13,691
1895	7,512	21,840
1896	7,204	21,159
1897	5,557	15,343
Average of 7 years..	6,436	16,157

The West of England production of copper, once so important in the world's market, is now quite insignificant, as it forms less than one four-hundredth part of the world's production.

Relative Production of the Two Counties.—We have seen that Devon has only produced 6 per cent. of the tin of the West of England. In copper she shows up somewhat better. Before the year 1845 the great bulk of the copper ores raised had come from Cornwall, and probably the whole product of Devonshire up to that time had not exceeded 300,000 tons. But in that year Devon Great Consols began to yield largely, and was soon followed by Devon United and other mines, so that the Devonshire production of the last 50 years has been over 1,100,000 tons out of nearly 5,000,000, or approximately one-fourth of the whole, and of this large quantity Devon Consols has yielded nearly 750,000 tons. But taking the whole period into account from 1501 to 1890, of the 11,500,000 tons of ore yielded by the two counties, Devonshire can hardly be credited with more than 1,500,000 tons at most, or little over 12 per cent.

In the following Table, the total production of the two counties is given; from official returns, wherever possible, at other times from the estimates of the best authorities available, with some carefully considered interpolations for intermediate periods. The figures, therefore, can only be regarded as approximations up to the year 1726, from that time to the year 1856 they are still partly estimated, though probably very near the truth; since that time they are either altogether accurate, or very nearly so.

Thus, the production of ore, which averaged about 100,000 tons per annum, from 1801 to 1840, increased to an average of 160,000 tons during the next 30 years (1841-1870), and

declined to an average of 34,000 tons during the next 20 years (1871-1890), since then the produce has been insignificant, as already stated.

Estimated Production of Copper Ore in the West of England from 1501 to 1896.

Date.	Average production per annum.	Totals.	Totals. (Centuries.)
	Tons.	Tons.	
1501-1550 ..	100	5,000	16th century 30,000 tons.
1552-1600 ..	500	25,000	
1661-1650 ..	750	37,500	17th century 100,000 tons.
1651-1700 ..	1,250	62,500	
1701-1725 ..	4,520	113,000	18th century 1,700,500 tons.
1726-1750 ..	7,600	190,000	
1757-1775 ..	19,500	487,500	
1776-1800 ..	36,400	910,000	
1801-1810 ..	67,333	675,330	19th century (97 years) 9,656,723 tons.
1811-1820 ..	82,149	821,490	
1821-1830 ..	115,486	1,154,860	
1831-1840 ..	144,555	1,445,550	
1841-1850 ..	155,450	1,554,500	
1851-1860 ..	185,274	1,852,740	
1861-1870 ..	141,646	1,416,460	
1871-1880 ..	54,831	548,310	
1881-1890 ..	14,243	142,430	
1891-1897 ..	6,426	45,053	
Grand Total		11,487,223	

The number of people employed in and about the copper mines is believed at one time to have reached the important total of 25,000. At present it is less than 1,000, a number which has been frequently and largely exceeded at a single mine.

The Great Extent of our Mining Operations.—I will now try to convey to you some faint idea of the enormous amount of work that has been done by the miners of the West of England. As regards what may be called the pre-historic periods of tin-mining, our guesses must be of the roughest kind. Yet in 30 or more centuries of work the total production of black tin must have been very large.

I have shown that the stream-tin production of the past seven centuries has probably been about 348,000 tons of black tin; and we may reasonably suppose that the 20 or 30 previous centuries produced at least as much, or say, 700,000 tons in all.*

* I believe the stream-tin production has been much more than this, judging from the former extent of the valley gravels.

Now, to get this quantity of black [tin], would be necessary to remove at lea[st] 4 times as much tin ground, and probabl[y] ,o times as much overburden, or, in all, n[ot] le[ss] than 3,080,000,000 tons, or say 1,500,0[00],0 cubic yards. Much of this has, of cours[e] be[en] removed with comparative ease by the [a]id running water, which would readily [c]ar[ry] away the finer sands and slimes. But, [on] t[he] other hand, much of the stonier porti[on] h[as] been turned over several times. Certai[nl]y, [it] represents an enormous amount of work-[v]ie[w] it as we may. Let me try to illustrat[e] [t]h[is]. The coast line of England and Wale[s], e[x]clusive of the minor promontories, is said [to be] 2,000 miles in extent, so that a wall o[f] th[at] length would fairly enclose it. I [h]a[ve] calculated that the ground removed b[y] t[he] streamers would make a mound all rou[nd] t[he] country 42 yards wide and 10 yards high. T[he] stone broken underground and brought t[o] su[r]face from an average depth of perhaps 1,00[0] [f]e[et], and which yielded 1,394,500 tons of bla[ck] t[in], must have been at least 70,000,000 tons. [T]h[at] broken and brought up from an average de[pt]h [of] perhaps 600 feet, and which yielded 11,5[0]0 [...] tons of copper ore, must have been no[t] le[ss] than 60,000,000 of tons. If now we add [t]he amount of "dead" ground brought out [f]ro[m] cross-cut adits and vertical shafts, as al[l] t[he] ground excavated in mining for lead, [z]i[nc], iron, and other minerals, the total can[not be] less than 180,000,000 or perhaps 200,0[00],0[00] of tons, and this would be sufficient to b[ui]l[d a] wall on the top of the mound 5 yards thi[ck] a[nd] 4 yards high. The metallic tin and [co]p[per] extracted from the whole of the ores pro[du]c[ed] from the mines and streams in the W[es]t [of] England would make a solid railing of [b]r[ass] all around the wall 14 inches thick.

I have estimated in some detail in a[no]t[her] paper* that the amount of sinking and d[riving] necessary to obtain the copper alone [would] amount to not less than 1,485 miles [on a] most moderate computation. For the t[in] excavations must have been considerably [...] and if we add in the work necessary for g[etting] the other metals, a total estimate of [...] miles will not be at all excessive.

I will not weary you with further det[ails of] such calculations, but I know I am with[in the] mark in saying that the West of En[gland] mining region, from a small part only [of a] mere strip of country, has yielded m[in]minerals to the value of upwards of £200,0[00],0[00].

* "Four Centuries of Copper Mining."

ng. In getting this, forests of timber have used to support the ground, while rivers iter have been brought to surface by the f fleets làden with coal.

nancial Results.—And what has been the cial result of all this work? I will first a few instances from mines that are still ous and flourishing.

von Great Consols.—This great copper arsenic mine is situated on the banks of Tamar, about four miles from Tavistock. first discovery was made in a pheasant rve, belonging to a former Duke of ord, who for years would not permit any ng operations to be undertaken. At last, e year 1845, work was begun by a small company, under the name of Wheal a. I have the pleasure of the personal aintance of several of the discoverers and workers, among whom I may mention ain Clemo, the present, and Captain Isaac ards, a former manager. The lode in al Maria rapidly yielded enormous quanti- of yellow copper ore. Other discoveries made in the immediate neighbourhood, he whole group—under the name of Devon t Consols—has been working continuously to-day, and is likely to do so for very years to come. At present there are 12 shafts and over 2,000 fathoms of pit-work ll working order, 45 miles of galleries, y 3 miles of underground, and 2½ miles of ce tramways, 11 powerful steam-engines, any large water-wheels (worked by the rs of the Tamar), 7 calciners and 3 ic refineries, 6 miles of railway, 2 notive engines, 50 ore and timber ons, a quay, &c., all paid for out of ngs, and certainly worth more at -up value than the whole of the sub- ed capital, which is only £20,000. By s of this insignificant working capital, er ores worth over £3,500,000 sterling, rsenic to the value of £500,000, have been 161 dividends amounting to £1,250,000 to the shareholders, while the Dukes have ved no less than £280,000 in dues.*

lcoath Mine celebrates its centenary of errupted working this year. On a total bscribed capital amounting to £120,252, s paid dividends amounting to nearly 0,000 sterling, and Lord's dues amount- o £309,478. In 100 years of working it produced and sold ores to the value of £6,218,086.* I am mainly indebted to the able managing director, Captain Josiah Thomas, for the following additional particulars:—There are five working shafts sunk under adit 455, 440, 425, 375, 338 fathoms respectively. Adit 28 fathoms from surface. The levels have a total length of about 75 miles. There are three pumping engines, the cylinders 85, 60, and 60 inches diameter respectively; also five winding engines, three being new and working at high pressure. The ore is crushed by means of 60 heads of Californian, two of pneumatic, and 236 of the old Cornish pattern; it is dressed by means of 27 Frue Vanners, capable of dealing with 120 tons of ore per day, and a great many buddles revolving frames, Bilharz tables, &c. For working the rock-drills underground there are three air-compressors. The pit-work consists of about 1,500 fathoms of various sizes. About 1,200 people are employed below and at the surface.

East Pool Mine.—This was once a rich copper mine but now, like its near neighbour Dolcoath, it produces mainly tin. It was started in the year 1834 and has worked ever since. It is now 300 fathoms deep. On a total called-up capital of a little over £3,000 it has given dividends amounting to about £500,000. In the year 1896 it took over its neighbour Wheal Agar, calling up then and since a further £12,000 or so of new capital for the purpose. The "lords" have received over £100,000 in dues. The amalgamated mines have already begun to pay dividends on the enlarged capital and seem to have entered on a new career of prosperity.

Coru Brea and Tincroft United.—These mines, together with Cook's Kitchen, have been lately amalgamated. They have all been highly profitable in the past, and although a little under a cloud just now are looked upon by all who know their history as very likely to be again rich in the near future.

West Kitty.—This is one of the famous St. Agnes tin mines—it has been working continuously since 1879, has called-up £66,000, and has paid £120,000 in dividends.

Wheal Kitty, its older adjoining neighbour, on a called-up capital of £25,000, has given dividends amounting to about £60,000.

Levant Mine has been worked continuously since 1820, and has given dividends amounting to many times the called-up capital. Brilliant

r some of these particulars I am indebted to Mr. Peter n, the able managing director.

* Dolcoath had been long and profitably worked before 1799, when the present working began, but the records are lost.

as the career of these mines has been, it has been equalled by scores of others in the past. Among copper mines I need only mention South Caradon, West Caradon and Marke Valley, Wheal Friendship, Fowey Consols (with Lanescot), Crinnis, the Consolidated and the United Mines, Tresavean, North Roskear, South Wheal Basset, Wheal Buller and Beauchamp, Condurrow, Crenver and Wheal Abraham, the Godolphin Mine, &c.; and among tin mines, Wheal Kind, Trevaunance, &c., Providence mines, St. Ives Consols, Ballewidden, Great Work, Great Wheal Vor, Wheal Metal, &c.

The Characteristics of the Cornish Miner.—What then are the qualities which characterise the men who have done all this work, and who, while doing it, have in many instances converted desolate moors into productive fields and gardens? I have known the miners of Cornwall for thirty years; I have had them working under me in Canada, the United States, and Mexico, as well as at home, and I am intimately acquainted with their work in Spain, India, Chili, Peru, Australia, and Burma. The Cornish miner's never-failing skill and inventiveness is appealed to whenever there is a difficult piece of work to be done. He is supposed to be rather unprogressive at home, but abroad I have ever found him enterprising. It must be admitted that he is more fond of scheming than of hard work; doubtless, his patron saint, St. Piran, taught him, "Ef e'e caant schamy 'ee must louster," but, after all, his scheming is often more valuable to his employer than his loustering could ever be. He has inherited from many preceding generations the handiness, resource, and intrepidity of both sailor and miner. He is a born prospector, and an ideal tributor. Almost every lode discovered in depth by cross-cutting in Cornwall is found to have been worked by "the ancients" at surface, and, if worth anything, as far down as the natural water level. He has a keen eye for the phenomena of mineral deposits everywhere, and one attendant disadvantage of the modern methods of mining—driving a-head by the aid of rock-drills and high explosives—has been the fact that the cool observation and consideration of the tributor has been rendered difficult or impossible, and, owing to this fact, I do not doubt that many payable branches and side-lodes have failed to be discovered. Among other personal characteristics, he is religious and a little superstitious, temperate, enthusiastic, and even heroic on occasion, but generally quite level-headed; a gen[illegible] satirical comrade and a true friend.

Education.—Until lately, the Cornish has laboured under the disadvantage great lack of education—elementary as w[illegible] technical. The Elementary Education have done much for the present gener[illegible] but there are still many most able and [illegible] miners of middle age who can neither rea[illegible] write, and who could not "pass" i[illegible] elementary stage of the Science and Department's examination in the "Prin[illegible] of Mining" to save their lives. They well how to do all kinds of difficult wor[illegible] they cannot explain themselves even [illegible] *viva voce* examiner; and this lack of edu[illegible] often prevents them from filling respo[illegible] positions for which they are otherwise fitted.

Technical Education.—The first atte[illegible] provide what is now known as tec[illegible] education for the Cornish miner, was ma[illegible] Sir Charles Lemon, of Carclew, more sixty years ago.*

In October, 1838, he issued a circu[illegible] "mine-agents and others" throughou[illegible] country and, after alluding to the ne[illegible] scientific instruction, he made the foll[illegible] very liberal offer:—

> "With a view to ascertain how far there is demand for such instruction, I will take on the expense and responsibility of an experime[illegible] two years. If I should find, on considerin[illegible] details, that my plan affords a reasonable pros[illegible] success, and if at the end of two years the should take up the subject, and carry it forwa[illegible] my death, I will endow the Institution in such as shall afford a reasonable hope of its permane[illegible]

This liberal proposal was warmly resp[illegible] to by the Royal Institution of Cornwa[illegible] appears from their "Report" of that published in 1839, wherein the foll[illegible] judicious remarks occur:—

> "What is required for the greater part of kind . . . . is a practical education in those sc[illegible] which are connected with every man's daily pation, the sciences of experiment, the scien[illegible] observation, the expedients of art. This de[illegible] object is now, we trust, in a fair way of ment, through the noble offer of Sir C[illegible] Lemon. . . . . The advantages which res[illegible] this Institution from the establishment of s[illegible] school, will, we feel confident, induce the mem[illegible] this society to place their museum and premises full disposal of the council in order that the

* See "Mining Schools of Cornwall." Rep. M[illegible] Cornwall and Devon, 1872.

every assistance in their power to Sir Charles in his arduous undertaking. The completion [...]r lecture-room and laboratory will afford [...]s for giving instruction to a mining class, and [...]mical and metallurgical research."

[...] school was started almost immediately, [...]inary instruction in algebra, geometry, and mine surveying, and mechanical [...]ng, being given by Mr. Joseph Dickinson, the Rev. T. G. Hall was appointed pro[...] of mathematics, the Rev. H. Moseley, of [...]nics, and Mr. John Prideaux, of chemistry [...]nineralogy. The course of instruction [...]he same as at King's College, London, [...] was continued during the years 1839-40, [...]Sir Charles Lemon proposed the establish[...]of a permanent college at Truro, offering [...]ovide a site, to subscribe £500 towards [...]ilding, and to endow the institution at [...]eath with the sum of £20,000. There [...] however, two conditions which led the [...]donment of the scheme. The first was a [...]sal that the mines should contribute half a [...]ng in the pound on the value of the ores [...]l for twelve years, which it was found they [...]not willing to do. The second obstacle [...]his condition that the college should be [...]urch of England institution, although [...]gements were suggested to prevent dis[...]tages to the Dissenters who might [...]l its classes.

[...]s quite evident that the scientific educa[...]of the working miner was not a part of [...]harles Lemon's plan at this time, since no [...]sion was proposed for his support while [...]t from the mine, but it would undoubtedly [...]aided greatly in giving better education [...] sons of mine agents, pursers, and other [...]g officials.

[...]wever, the plan failed, and nothing more [...]one for 12 years, when, in 1853, the Royal [...]ution took the lead in another effort, [...]n was supported to some extent by the [...]l Geological Society of Cornwall and by [...]oyal Cornwall Polytechnic Society. The [...]l was again located at Truro, under [...]rs. Hobson and Rickard, as teachers of [...]ematics and mechanics, and Mr. Hodge, [...]acher of chemistry and mineralogy. The [...]dance was small, though some good work [...]done, and several of the pupils were after[...]s distinguished in connection with mining [...]its.

[...]is second effort failed, like the first, for [...] of general support, and the school was [...]d towards the end of 1858. Still, the [...]l Institution was not disposed to give the matter up without a further effort, and a peripatetic school was started. This scheme embraced a somewhat advanced course on chemistry and mineralogy at Truro, for about three months in the year, with classes open to working-miners in the various mining districts; some being of the nature of mutual improvement classes, where the members recounted and discussed their experiences, while others were under the direct instruction of the teacher. Mr. Richard Pearce, who had been the laboratory assistant in the second Truro school, and is now the able managing partner of the great Argo Smelting Works in Denver (Colo.), was appointed as teacher and director of this third school, and at once established a class at Pool near Camborne. About this time, too, Mr. Robert Hunt interested himself in this peripatetic plan for carrying the instruction to the immediate neighbourhood of the mines and of the miners' cottages. A considerable subscription-list was secured, from landowners and other sympathisers, and from a few of the leading mines, to defray the necessary travelling and other expenses, and the Miners' Association of Cornwall and Devon—the fourth of Cornwall's mining schools—was established at Camborne on the 26th of October, 1859.

Mr. Pearce was engaged as lecturer to the new institution—another lecturer, Mr. Charles Twite, was soon after engaged, classes were opened in a great many mining centres, and the work hitherto carried on by the Royal Institution of Cornwall was soon absorbed into the general scheme of the new association.

The Miners' Association continued its work under Messrs. Pearce and Twite, then under Dr. Clement Le Neve Foster and his successors, and, occasionally, aided by liberal grants for special subjects from the City and Guilds of London Institute, and the Society of Arts, until the year 1885, when it was amalgamated with a younger society, hitherto known as the Mining Institute. The work of instruction by means of local classes still went on, under the control of the Mining Association and Institute of Cornwall, Camborne being now the headquarters, a change due mainly to the fact that, owing to the liberality of various members of the Basset family, excellent class-rooms and modern laboratories had been built there, and a number of scholarships for needy students had been established. In 1895 a further change took place, for the Mining Association and Institute was then practically absorbed into the Camborne School of Mines, the local classes in other districts being now left to

themselves. The Camborne Mining School, under the direction of Mr. J. J. Beringer, Mr. W. Thomas, and their able assistants, is now a most successful and prosperous institution where every branch of mining engineering is taught, and well taught. Besides laboratories, class-rooms, &c., and a museum, it owns and runs the South Condurrow tin mine, not for profit but for experience. There are 80 students working in this mine, each for two or three days a week. The shaft, tram-roads, head-gear, &c., are all in thorough order. The air-compressing plant and rock-drills are always at work, and there is now to be added a new compound engine, Californian stamps, and up-to-date dressing plant. There are also from 50 to 60 students of mine surveying.

Another off-shoot of the Miners' Association is the Redruth School of Mines, which was first established in the year 1860, and is now under the direction of Mr. J. P. de Castro, B.A., and his assistants. It has a good laboratory and museum, and is doing very good work.

There are also minor offshoots at Penzance and Helston, while at Truro the private school under the direction of Messrs. Henderson and Son, is of particular advantage to those who desire to have first-class instruction in mine-surveying and other branches of mine engineering.

For the last few years most of the local efforts have been aided by grants of money from the Cornwall County Council. The result of all this is that Cornwall is continually producing and sending out into the world miners who are second to none in the profession, and who are capable of doing the best possible work—of making as good "bricks" as can be made where they are supplied with the necessary "straw," in the shape of capital. Cornwall has now become in a very real way a mining school for all lands, and has provided mining inspectors for Kimberley, British Guiana, and several of the Australian Colonies, as well as managers of such mines as the De Beers, Ferreira, Sheba, and Rio Tinto, and for such metallurgical establishments as the Argo Works in Denver. And I may add that the transactions of her local scientific societies will ever be classics to students of mining and chemical geology.

The Decline of Cornish Mining.—The present generation has indeed witnessed a most serious decline in mining, and the closing of a great majority of the mines. Thus, if we compare the statistics of the year 1897, the last yet issued, with those for 1867, we find that the value of the products of the tin and copper mines has fallen from £1,106,807 to £269,511. My object will now be to th[...] the causes of this decline as far as p[oss]ibl[e] and to consider the prospect of a reviva[l].

But before going on, I may remar[k] th[at] Cornish mining has been supposed [to be] ruined several times, "scat up," as the[y] say, and has several times recovere[d] a[nd] reached heights before unknown. The[re] w[as] one such period of ruin in the reign of [Qu]ee[n] Elizabeth, before Sir Walter Raleigh [was] Warden of the Stannaries. There was a[no]th[er] in the reign of William III., and still a[no]th[er] at the close of the last century, when [V]a[...] wrote his dismal account which I have a[lre]a[dy] quoted. But a Cornish miner is never [b]ro[ke] till his "neck's broke," and that is not y[et].

The chief cause of the decline of [co]p[per] mining has no doubt been the partial e[xh]au[s]tion of what has been called the coppe[r z]on[e]. This is in general limited to those port[ion]s [of] the lodes which are included between [the] [...] and 250 fathom levels; but in some [r]a[re] instances it has started almost from th[e] [...] surface and extended downwards, far bel[ow] [...] 300, as in several of the great mines [of the] Gwennap district. That this partial exha[ustion] was really the prime cause of the dec[lin]e [is] evident from the fact that the culminati[on] [...] reached in the years 1855-6-7, while ye[t] [...] was no very serious fall in price, such as [...] not have been generally met by imp[ro]v[ed] methods of ore treatment, for 20 years [a]ft[er]. Another cause was no doubt the incr[ea]s[ed] cost of working mines, which were bec[omi]n[g] continually deeper and wetter. The [decline] having set in, it was then accelerated b[y] [...] serious falls in price, consequent on the [...] supplies from foreign sources, and esp[ecia]l[ly] from Chili, Spain, and the United States.

The average prices of fine copper [...] nearest pound sterling, before 1856, had [...] well over £100 per ton for very many [...]. The prices since then, taking periods [...] years, are as follows:—

	Per Ton. Fine copper.	Per Ton. Chili & G.M[...]
1856-60	£115	—
1861-65	100	—
1866-70	78	—
1871-75	87	—
1876-80	72	—
1881-85	61	—
1886-90	62	£58
1891-95	—	44
1896-98	—	50

The present price of Chili bars or G.M[...] about £71.

ospects of a revival of Copper Mining.—be true that the copper zone is practically isted, it is evident that no considerable il is to be looked for. I doubt whether it much exhausted as many suppose; rather a question of price, and partly a question ethods of working and of sale.

th the prices ruling from 1881 to 1897, vith the old methods of working, few of reat West Country mines of the past would been able to pay large and regular ends, and many of them could not have their way. But I do not believe in any such anent low-level of price. In the mean- methods of working have been greatly pened, and, before concluding this paper, ll endeavour to set forth some reasons for in the future. I do not, of course, ose that Cornwall will ever again supply really important part of the world's con- ption of copper, large as this has now me. But if the recent considerable nce of prices is maintained, or nearly so, leed a price of £50 for crude copper can ounted on, many of the too-hastily aban- d mines of the Marazion, Gwennap, St. ell, Caradon, and Tavistock districts, can nade to pay if they are worked on a suffi- tly large scale, and with the best modern iances. There is an additional reason for pening and deepening such mines in the roved tin prospects, for, with the expe- ce of the Carn Brea district before us, the ability of meeting with valuable deposits n by sinking below the copper zone must egarded as an important consideration.

ead, Zinc, Iron, Arsenic, &c.—As already ed, these have only been important com- ents of Cornwall's mineral riches under ex- tional circumstances. At present, only the is of importance, but it may happen that others will again attract attention, and d notable profits, though they can never, arately or combined, play the part which per and tin have played.

in Mining.—This has never sunk so low copper mining, and I believe it has a good ure—perhaps a future as brilliant as its past. late depression was due to a run of excep- ally low prices, and not, as some assert, to austion of the mines, or the lack of proper hods and appliances. I do not say that can be proud of all that is done in Corn- l. But even with the best appliances, and best methods, the price of tin has been for rs unremunerative. I believe the depres- n was in the main due to purely temporary causes, which have to a considerable extent passed away, and which may perhaps never return.

Complex Ores.—A great many of the low-grade and complex ores of the West could, no doubt, be more advantageously dealt with by raw smelting methods, or by wet processes, to be carried on at or near the mines. In this way, the almost universal presence of "values" in gold and silver could be made a source of profit to the miner.

In some respects we are not so well situated in Cornwall for the sale of mineral products as our competitors are in the Rocky mountains; a great many of our lodes, and even many of our burrows, are capable of yielding large quantities of low-grade and complex ore substance which would, by a rough calculation, yield a product of composition somewhat as follows:—

Iron	20·0 to	30·0	per cent.
Copper	2·0 ,,	3·0	,,
Zinc	3·0 ,,	8·0	,,
Tin	— ,,	0·5	,,
Arsenic	4·0 ,,	8·0	,,
Sulphur	2·0 ,,	30·0	,,
Silica and silicates	15·0 ,,	25·0	,,

Silver 1 to 3 oz., Gold 1 to 3 dwts. per ton.

Were there a steady demand for such stuff here as there is in Denver and other parts of the United States, thousands, perhaps millions of tons could be produced by a rough concentration from the waste heaps, "stowage," and selvages of our mines at such a cost as would yield a fair profit to the miner. At present, unfortunately, there is no market for such a product, either in Cornwall or Swansea. In Colorado it would often sell for 20s. and even 30s. per ton, being used as a flux in smelting siliceous silver and gold ores.

Royalties.—Since the mines have for the most part reached considerable depths, so involving heavier hoisting and pumping charges, these have in general been much reduced, particularly in the case of tin. But there are still many cases where the dues are far too high, and especially as regards copper. Under modern conditions of the copper trade, and until the principle of paying dues only on profits has been adopted, the dues on copper ought rarely to be more than one-fortieth of the sale value, and even then they will absorb as much as 30 or even 50 per cent. of the profits.

But more vital even than a reduction of dues is a removal of the restrictions in modes of treatment and of sale. In many cases of low

grade and complex ores the sale by private contract is far more advantageous than by the sham semi-public competition, which is called ticketing, and yet this latter mode is usually insisted on. It is even insisted on in some instances when the ores could be advantageously "refined" up to a certain stage on the mine itself. For example, many ores need to be "burnt" at an early stage of their treatment, and this has been absolutely forbidden in a great many leases even when the lessees are prepared to give substantial guarantee to do it in such a way as to avoid l chance of damage to the surrounding property. In this connection, however, I am bound to say that the larger landowners are usually considerate, and it is the small men who are most disposed to churlishness and greediness.

Working Capital.—From all this it will appear that, in my opinion, our principal need is working capital. Modern conditions of mining call for much larger capital expenditure than did those of former times. The mines are deeper and wetter, and they require more and better plant, as well as to carry their explorations farther ahead. I have shown how very successful the Cornish mines have been in the past. Why is it, then, that the necessary capital is not forthcoming?

1. In these days of Imperial expansion—with which I do not doubt all in this room are in sympathy—there is yet a danger that some of our home industries may be overlooked or neglected, even when they are well worthy of attention. And this applies particularly to mining. It cannot be denied that this West of England mining-field has been thus neglected for many years past. The extension of the empire is a fine thing, and it makes careers for our boys. But could not a little be spared to keep the home pot boiling?

2. One cannot but remark that to the ordinary speculator the word *gold* acts like a charm, and this "open sesame" we cannot use in Cornwall. And yet in general, and in spite of the great fluctuations in price, which, in the case of gold have been prevented by legislation, mines of the common metals are far more profitable, on the average, than gold mines. Let me give you a notable example from present-day experience.

The dividends paid by the Rand Gold Mines during 1898 amounted to very nearly £5,000,000 sterling. But this was the result of the investment, directly or indirectly, of over £100,000,000 sterling, in more than 400 companies, which are still in existence, besi[...] considerable amount lost in companies [...] have lost all their capital and disappeare[...] course, those lucky investors who got in[...] successful mines at par before their su[...] was assured, who have held on till now [...] who have also been fortunate enough n[...] get into the failures, have made large p[...] But the general investing public can [...] have made an average of 2½ per cent., [...] very many have lost everything. What [...] we not do in Cornwall if we had [...] £100,000,000—but £1,000,000 of mere wo[...] capital? This amount spent honestly [...] intelligently, under your eyes so to s[...] would re-open and equip twenty groups, [...] of three or four mines, that ought ne[...] have been closed; and would, I believe [...] us a dozen dividend mines for a long ser[...] years.

And now to sum up. I believe the Co[...] mines and the Cornish miners are seco[...] none in the world. No country has had [...] mining triumphs than the West of Eng[...] can show, and the few I have mentione[...] night might easily be extended into [...] twenty times as long. The known mine[...] by no means exhausted, and it is certain [...] very many valuable ore deposits still re[...] unworked, and probable in the extreme [...] many others will yet be discovered. Th[...] reason to believe that prices, both o[...] and copper, will in the future, as in the [...] average far higher than they have done d[...] the past few years; our men are skilful, an[...] landlords in general are disposed to be [...] siderate. "We've got the stuff, we've go[...] men, we want the money too." But this ne[...] sary working capital we must have. [...] must be done on a larger scale than hith[...] and the mines must be grouped under [...] control, so as to secure the advantages of [...] class machinery and plant, and thorou[...] able management. Let us have just a [...] per centage, nay, even a penny in the po[...] of the capital which has been so lavish[...] India, South Africa, West Australia, and [...] Klondyke, and I am sure that our home m[...] will be as profitable in the future as they [...] been in the past.

DISCUSSION.

Mr. WILLIAM SEMMONS said he could bear [...] mony to the good work done by Mr. Colli[...] connection with the School of Mining in Corn[...]

he had modestly omitted his own name from of men who had been engaged there. As one ormer secretaries of the old Mining Association, years ago, he had a distinct recollection of ollins coming into the county, making himself ie there, and doing a good deal of work. In tion with the improvements of mining, he say that a mine with which he was connected e second one to introduce wire rope, and he membered the difficulty they had in getting he judgment of Captain J. Thomas, then er of Dolcoath, so that he was pleased to at that mine was now prominent in bringing in achinery. Seeing the immense dividends paid ie of the old mines with their primitive appli- they could imagine what might have been done had had the mechanical contrivances they now sed. Those who had travelled about the world iave noticed that many of the most prominent ons in connection with mining were held by old its of theMining School, and also that there were very good miners who could not read or write, uring the last fortnight he had come across two vhom they wanted to send down a mine as timber ieither of whom could do a common sum in arith- He should like to emphasise the closing part paper as to the probability of future profits made out of Cornish mining. His experience nore with smelting than mining, but he could say that the several extensive districts of Corn- such as Scorrier, had never yet been developed y considerable depth; about 100 fathoms was hing like the limit to which the old mines were d, because at the time of their prosperity there ot the same facility for pumping, and there were compressors or boring machines. If a million oney were laid out in Cornwall there would greater return for it than the same expenditure l secure in any other part of the world, and he l something would be done. There were large ing works in Wales for the manufacture of spelter, hen, during the recent excitement about Fashoda, s thought that possibly their supplies of ore from ontinent might be interfered with, spelter mines opened in Wales, and he hoped great results d follow: at any rate, it was a step in the right tion, and he hoped there would be a still further opment of English mines, with English capital.

. MAURES HORNER said he was only acquainted ically with the east of Cornwall, and there was a g in the county that anybody who had to do with ast knew nothing about mining. His connection it was quite accidental, being asked to join a any which he found on his return from abroad a year's absence was anything but flourishing, not boasting much knowledge of mining, his npts to regenerate it were not successful. He ed, however, what were the difficulties which met there, the greatest of which was that all the best rs had left the county. If there were two or three years of good prices, no doubt many of these men would come back, and then there would be some chance for the county. He also thought improved methods of treating the tin ores were required; there ought to be better modes of concentration and of smelting.

Mr. J. I. TRACY said it appeared as if the Cornish miner had been starved out, and was now found in every other part of the world, but not in his own county. The same thing had happened elsewhere. Mexico produced silver for the world, but the Mexicans were still poor.

Mr. E. ASHMEAD said he had listened with much interest to the paper, and though he could not speak as a geologist or an engineer, he had been more or less connected with mining for the last 50 years. Mr. Collins had given statistics of some mines which paid remarkably well, but the real question was, would Cornish mines, as a whole, produce profit-able results. He was recently looking at a book, published in 1856, called "British Mines as a Means of Investment," by the late J. H. Murchison, a gentleman largely connected with Cornwall, and he there gave a list of 92 mines which had paid dividends for the nine years ending in 1854, to the aggregate amount of nearly two millions. The question was, Could Cornish mining be revived, and could capital be found for it? His impression was that Cornwall could not do it by herself, and that the capital must come from outside to a large extent. The rich men in Cornwall had not assisted outside adventurers as they ought. Whenever a mine had been started from outside, with an office in London, Cornish men stood aloof. He could instance three mines, of which he was secretary, formed upon the reports of eminent Cornishmen, which were looked upon as being certain of success, and they appealed to the merchants and smelters of Cornwall to assist; but on looking over the list of shareholders in one of those mines, he found only three Cornishmen out of 150. If Cornwall wanted her mines worked, she must join with the outside adventurer as a brother, and there would then be more prospect of success. The working also must be on a more vigorous scale, and carried to greater depths. In Africa, where mining was quite recent, they already had deep mines, and they must have the same in Cornwall, and better machinery. The whole system had been too antiquated; people nowadays wanted to see a return for their money within a year or two. Again, the lords in Cornwall did not treat shareholders in a proper manner; all the leases were drawn by Cornish lawyers, and they were all in favour of the lord and against the adventurer. He had known companies to pay large sums for damaging land which could not possibly be damaged, because it was worthless.

Mr. A. O. GRANGER said his experience was confined to the United States, but if Cornish miners

were as well distributed over the rest of the world as they were over that country, he should be surprised to hear that there were any left in Cornwall. In the States they found Cornish miners to be resourceful and good emergency men. In mining you were constantly running against snags of some kind, which required prompt action, and it was usually found that a Cornish man would get over the difficulty successfully before he reported it to the manager.

Mr. B. KITTO said he remembered meeting a clergyman in Cornwall, twenty years ago, who told him that he had travelled a great deal, and he found the Cornish miner the most intelligent working man he had met anywhere. If he went down a mine and spoke to one of these men, he could tell him the depth at which he was working, the size of the lode, the way it ran, the dip, and would give an intelligent answer to any question he asked; whereas in the colliery districts he could never get such information at all. Mr. Frank Oats, a St. Just man, who was largely interested in the Levant Mine, said, at a public meeting very recently, that the Cornish miner was the best in the world, but the best miners were driven away from the county by the small wages they were paid. Whether there were enough men left to do the work, he could not say, but when he was there he found a robust and intelligent class of men still there; and the mining schools, now established, were doing very good work in the way of technical instruction, which had been much needed. On the Continent, where the minerals belonged to the Government, mining schools had been in existence 150 years, and there had been a long succession of excellent professors there. Years ago Cornishmen used to go there to study mining, but he did not think they did so now. About 1716, a mining school was established at Chemnitz, which was also very successful. Some time ago he met a man who had considerable experience of mining on the Continent, and asked him what school he liked best to draw his men from; whether the Royal School of Mines or the Cornish school were equal to those on the Continent? His reply was that he should invariably choose a man from the English School of Mines if he could; the other men had a higher scientific instruction, but their knowledge seemed to be in their way—they were not able to apply it. He would remark that there were other minerals of value in Cornwall besides tin and copper. A large quantity of arsenic was produced, and of late years wolfrum had been turned to account for the manufacture of tungstic acid. Formerly it was left on the rubbish heaps, and anybody might take it away; but it was now worth £70 a ton, and East Pool, Carn Brea, Tincroft, and other mines had sold considerable quantities of it. Cobalt and uranium were also valuable, and within ten years a regular lode of the latter ore had been opened up in the St. Stephen's parish, and 150 tons had been exported to Germany. Probably one reason why there had been a defi of capital of late years was that many people d like what was called the cost-book system. Th of tin had fluctuated very considerably; somet was only half the price it was at others, and wh price fell very low the mining captain thou would be sure to go up again shortly, and in som kept back in the accounts large sums of money had been expended for fear of discouragin adventurers, with the idea of wiping them off the price improved. Two or three cases of th had had a very bad effect, and though the cos system, when properly worked, was undoubted best, he believed that any great extension of in Cornwall would have to be on the limited li company system.

Mr. B. H. BROUGH said he was not quite clea the paper at what date the Dolcoath Mine was ori worked. He understood Mr. Collins to say i place that it was at work in 1768, and in a place that it was this year celebrating its cent He presumed, however, that it had been worke a much earlier date. One could wish that Mr. (had extended his study of the history and statis metal mines to other parts of the kingdom, might have removed a great deal of the ign which seemed to exist on the subject. The day there was a sensational account in a m newspaper of the discovery of some Phœnician in the Mendip hills, the writer being evidently ignorant of the fact that Mr. Robert Hunt had lished in his book on "British Mining," plans "Maindips," as they were then called only a few ago. With regard to the story of the fortunate date who obtained his first-class at the exami with so little practical knowledge, he thought probably due to the fact that Mr. Collins had writ admirable a little manual on the subject, that a who learned it by heart could easily obtai distinction.

Mr. COLLINS, in reply, said several of the mentioned by Mr. Kitto would be found refe in the paper when it appeared in print. He th very probably future mining companies wou carried on, on the limited liability principle he did not see that keeping back account anything to do with the cost-book system. might be kept back under any system, if the au did not do their duty, but not otherwise. Ashmead, for instance, had to audit the accou did not think they could be kept back und system. They did not know when Dolcoath be work—probably several hundred years ago—bu knew that before 1785 it had produced £2,c worth of copper. It was then stopped for 15 and began again in 1799, and it was the cente that event which was being celebrated this yea

The CHAIRMAN, in proposing a hearty v

Mr. Collins, said there was certainly one in the paper, and that was any reference to rtant work done by himself in connection Cornish Mining Institute, though the names other gentlemen had been mentioned. Last he had occasion to examine the Camborne which was a very remarkable institution, l mainly by private enterprise, with but a ount of assistance from public funds. To nt it imitated the foreign schools of mining, lition to scientific training, it provided for work, which was very valuable. Apart from id for Cornwall, it was a great assistance to er and others in the Central School in to which it formed a sort of branch, and Mr. and Mr. Thomas did all they could to assist students in their work. With regard to the Cornish mining, his recollections went back ulminating point of copper mining about possibly, what he saw then left too vivid an on on his mind, but he was in considerable with Mr. Collins in his anticipations. It seemed remarkable that all work should sed in the great copper region of Scorrier. ere wonderful mines at one time, and one rdly believe that they were exhausted com- But if they were taken up again, it would be on a larger scale, and with better y. The great curse of Cornwall had been the nes, and especially the old boilers, for however engine you might have, you could not get good t of it without a good boiler. He quite agreed Cornish miner was the best in the world, but, ays, he must have good machinery and plant with.

ote of thanks was carried unanimously.

Miscellaneous.

E 1898 VINTAGE IN GERMANY.

1898 vintage in Germany will go on record as he poorest, both as to quantity and quality, t years. The main cause, in the opinion of ted States Consul at Mainz, is to be sought in unfavourable state of the weather during the ing period of the vines. At the same time, ases of the vine spread to an alarming extent. average, hardly one-fifth to one-fourth of a s been gathered, and prices have consequently gh; but it is very doubtful whether they can up, owing to the rather poor quality of the intage. In Rhenish Hessen, early burgundies from £35 to £42 per 1,200 litres (317 gallons) t. According to the Oechsle system, the auged 70° to 80°. The Portuguese grapes of the Haardt hills were gathered at the beginning of October. The average price paid was about £17 per 1,200 litres (317 gallons) of must. On the middle Haardt hills prices averaged £18 15s., and on the lower Haardt, £16 13s. per 317 gallons of must. On the Nahe, the must of early burgundies gauged 75° to 85° with an acidity of 7 to 8 per cent. Early burgundies realised £26 13s., and Portuguese £17 14s. per 317 gallons of must. The gathering of the red wine grapes of the Middle Rhine dragged along to the end of October. The result was extremely meagre. The must gauged 68° to 90°. The general gathering of the grapes began at the end of October, and was accomplished by the middle of November. In Rhenish Hessen the crop averaged one-tenth to one-third of a normal year, according to the location of the vineyards. In the Rheingau, the grapes were not juicy, and it took 39 to 40 cwts. to produce 1,200 litres (317 gallons) of must. Vineyards of 12 to 14 acres produced only from 150 to 230 gallons of must. In the valley of the Middle Rhine, the result was no better. The must gauged 60° to 75°, with an acidity of 12 to 15 per cent. The vintage on the Upper Moselle, resulted in a fourth of that of a normal year. Prices of must averaged £24 per 317 gallons. On the Middle Moselle prices averaged about £46 per 317 gallons. Must gauged 70° to 80°. On the Lower Moselle prices ranged higher than in 1897, notwithstanding the poorer quality. In the valley of the Nahe, the quantity was very small, and, judging by the must, the quality promises to be similar to that of 1896. The vintage of the white wine grapes of the Haardt hills was rather unsatisfactory. In the other wine-growing provinces of the German Empire—Baden, Franconia, Wurtemburg, and Alsace-Lorraine—the year's vintage was equally disappointing.

THE FRENCH SILK INDUSTRY.

The production of the Lyons silk factories in 1897 is, according to the Commercial Attaché to H.M. Embassy in Paris, estimated at £16,200,000 as compared with £16,000,000 in 1895. This is the largest figure that has ever been reached. The steam weaving mills were kept busy, especially during the last six months of the year, and the hand weaving machines were particularly brisk. On the other hand, the manufacturers of plain pure silks complained seriously of the dearth of orders. Black silk tissues were little in demand, having given place to the more modern coloured silks. From 1896 to 1897 the production of plain pure silk tissues, not including silk handkerchiefs, fell from £5,200,000 to £4,440,000, while the production in 1896 had already fallen off by £600,000. With regard to the other manufacturing districts for pure and mixed silks, such as St. Etienne, Roubaix, Tourcoing, and in Picardy, and the various hosiery, trimming, and lace factories, their output is valued at £24,600,000. In 1897 the manufactories of St. Etienne turned out goods to the value of

£3,500,000, as compared with £3,466,800 in 1896. The total production of the district is valued at £3,680,000. On account of the change in fashions, the manufacture of plain pure silk ribbons shows a decrease of £320,000, but about one-half of this loss is compensated for by the increased production of plain mixed ribbons. The manufacture, also, of finished ribbons and velvets continues to increase, and the French houses still hold the first rank, notwithstanding the keen competition of the Swiss and German manufacturers. The United States now manufacture more pure silk ribbons than the French, and the production in that country appears to increase. The importations of silk tissue into France in 1897 amounted to £2,080,000 against £2,012,000 in the preceding years, and the exportations to £10,836,000 as compared with £9,880,000 in 1896.

EMIGRATION FROM BRITISH INDIA.

The *Board of Trade Journal* contains some statistics relating to emigration from India in the year 1897-98, obtained from the India Office.

The figures relate solely to emigration as carried on under the laws regulating emigration, and they take no account of the numbers who leave India as passengers, not having been recruited by emigration agencies for service in the colonies. They are also exclusive of the persons who leave India in pilgrimages to the holy places in Arabia, of whom small but uncertain numbers settle out of India.

The number of emigrants from India during the eleven years, 1887-88 to 1897-98, amounted to 156,388, making an annual average of 14,217 persons. Few, if any, quit the country with the intention of permanently establishing their domicile elsewhere, but leave in hope of returning with their savings to their homes in a few years. The number of persons who returned during the last eleven years amounted to 69,686, an average of 6,335 yearly, or less than one-half of the number who left India; this is also very nearly the proportion for the twenty years for which the facts are stated in the Tables.

The mortality among emigrants is high in some of the colonies to which they go, and of those who survive, a substantial proportion elect to continue to work in the colony after their term of indenture expires, and many of these never return to India. In Mauritius, for instance, about 69 per cent. of the population (256,000 out of a population of 372,000) are Indian settlers and their descendants, and in Trinidad and elsewhere the settled Indians are increasing in numbers.

There are five places in India from which emigration may legally be carried on—Calcutta, Bombay, Madras, and the two French settlements of Pondichery and Karikal. From Bombay emigration ceased many years ago, and general recruiting has never been resumed, labour in the Western Presidency being, on the whole, so well paid that there is but little inducement to emigrate to the coolie-employing colonies. That port and the port of Karâchi, however, have recently been used for the shipment of male labourers destined for work on the Uganda Railway, who were recruited under agreements made with or on behalf of her Majesty's Government under the powers conferred by section 106 of the Indian Emigration Act, XXI. of 1883, as amended by Act I. of 1896. From the French settlements there has been no emigration since 1884, except in one year, 1888-89.

The Port of Calcutta is the most convenient for the shipment of emigrants drawn from the impoverished masses of the thickly-populated districts of Oudh, Bihár, and the eastern section of the North-Western Provinces, and the main stream of emigration flows from that region down the Hooghly. Of the persons who emigrated from India in 1897-98, as many as 7,347 (being 54 per cent.) were shipped from Calcutta, almost all of them from the North-Western Provinces, Oudh, and Bihá. From Madras 3,345 were shipped during the year, recruited exclusively from the Madras Presidency, and mostly from the southern (Tamil) districts. From Bombay and Karâchi 2,793 male labourers left during the year under agreement to work on the Uganda Railway, and these were mostly recruited from the Panjab.

The number of emigrants in the last three years has been relatively small, notwithstanding the distress in the tracts whence the emigrants are principally drawn, probably because the cane-sugar industry has been suffering from depression.

The destinations of the emigrants in the last seven years were as follows:—

To	1891-2	1892-3	1893-4	1894-5	1895-6	1896-7	1897-8
Mauritius	989	...	485	1,029	1,746	802	426
Natal..........	3,349	3,119	2,612	3,592	3,337	4,038	6,036
Demerara.....	5,231	4,723	5,883	7,200	1,908	2,417	1,194
Trinidad	3,285	2,620	1,926	3,185	2,177	3,043	1,851
Dutch Guiana	698	1,075	1,104	1,279	1,696	500	618
Fiji	1,985	781	1,082	1,432	565	1,953	567
Jamaica	1,000	...	486	711	470	...	...
St. Lucia	...	...	157	..	...	...	...
Mombassa ...	...	...	...	...	...	2,819	2,793
Total	16,597	12,318	13,735	18,428	11,899	15,572	13,485

The emigrants who sailed from Calcutta during the year went to British and Dutch Guiana, Trinidad, Natal, Fiji, and Mauritius. The emigrants from Madras went to Natal and Mauritius. There is a considerable flow of native labourers from Madras to Ceylon and the Straits, but this traffic is not conducted under the provisions of the Emigration Act.

TOBACCO CULTIVATION IN SZECHUAN.

The tobacco plant is grown all over the province of Szechuan, but more abundantly in the districts of

Pe-shan Hsien, which is about 150 li (60 miles) north-east of Chung-King, and Kin-t'ang Hsien, about 100 li (40 miles) east of Chengtu, the provincial capital. The plant grows to the height of about 2½ to 3 feet from the ground, and the usual time for planting the seed is during the tenth or eleventh moon (November or December). The method before putting the seed into the ground is to sift out a quantity of soil and manure it. When dry, the seed is wrapped with this soil, and put into the ground at intervals of a foot-and-a-half. The soil must not be rich, and ground where cereals have not been already planted is generally chosen. According to Consul Smithers, of Chung-King, there are three crops a year—the first is cut six months after it has been planted, the second twenty days afterwards, and the third crop twenty days after the second crop. As soon as it is cut it is hung up to dry for about a fortnight in a sheltered place, with a good draught of air, so that it may dry quickly. When ready for sale it is done up in bundles weighing 70 to 80 catties (93 to 106 lbs.) a piece. The Kin-t'ang tobacco leaf receives a little more care; after it is dried it is put into a press to enable some of the juice to be pressed out, and the leaf made much milder than the other leaves that are sold in the market. It is done up in bundles of 40 to 50 catties (53 to 66 lbs.) each. The seed is sown under shelter. When the leaves are ready they are picked and exposed to the dew for several nights; they are then dipped in a dye and hung up to dry again before being taken to the markets for sale.

Obituary.

J. M. COOK.—Mr. John Mason Cook, head of the firm of Messrs. Thomas Cook and Son, the travelling agents, who died on Saturday, the 4th inst., was a member of the Society of Arts since 1883. In 1893, when the Council, acting as the Royal Commission for the Chicago Exhibition, arranged for a special private excursion of the members of the Society to the Exhibition, Mr. J. M. Cook carried out the arrangements with great success. Mr. Cook had previously assisted the Executive Committee of the British Section at the Paris Exhibition of 1889, by acting as their passenger agent.

Mr. Cook joined his father, Mr. Thomas Cook, in 1864, and greatly developed the business founded by him. He had previously served in the offices of the Midland Railway Company. In the obituary notice of Mr. Cook in *The Times*, it is said, "By the time of the opening of the Paris Exhibition, of 1867, the business had become very large. The next important stage was the invention of the hotel coupon system; the next, the development of the Harwich route to the continent, in which all the difficult negotiations with the Belgian and German railway officials were brought to a successful issue by Mr. J. M. Cook after a long struggle; and next, the opening up of the East to the British tourist."

General Notes.

MUNICIPAL ENTERPRISE.—The Government have decided to appoint a joint Committee of the Houses of Lords and Commons to consider the trading enterprises of municipalities, and the following statement was made in the House of Commons on Thursday, 2nd inst.:—Mr. Bartley asked the First Lord of the Treasury whether he would consent to the appointment of a Select Committee of the House to consider the clauses which appeared in so many private Bills this Session authorising municipalities to enter into trading enterprises, and the resolutions of the various Chambers of Commerce on the subject. Mr. Balfour: "In answer to the hon. member I have to say, the important question he refers to is one deserving further investigation, and we think a proper method of investigation would be by a joint committee of the two Houses." Sir J. Lubbock asked whether the Government would take steps to appoint the committee at an early date, and whether the reference would be wide enough to include the whole subject. Mr. Balfour: "We shall proceed at once to appoint the committee; and no doubt the reference will be sufficiently wide to include all the subjects referred to in my hon. friend's question."

ELECTRIC RAILWAYS IN GERMANY.—According to the United States Consul at Hanover, up to the end of the year 1891, the number of cities in the German Empire enjoying the advantages of electric street railways, was three; up to the end of 1892, five; 1893, eleven; 1894, nineteen; 1895, thirty-two; 1896, forty-four; 1897, sixty-one; and on the 1st of September, 1898, no less than sixty-eight. In thirty-five other cities or districts, railways are in course of construction, or finally determined upon. The entire length of electric lines in operation in Germany on September 1st, 1898, was 885 miles, the number of motor cars was 3,190. The length of the new lines in course of construction, or about to be begun, at that date was 677 miles. Most of the large industrial cities in Westphalia and the Rhine Province are connected by a network of electric roads, which serve not only for passengers, but for goods traffic.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 15.—"Liquid Fuel." By Sir MARCUS SAMUEL. Sir EDWYN S. DAWES, K.C.M.G., will preside.

MARCH 22.—"Electric Traction." By PHILIP DAWSON. Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

Mr. WALTER HUNTER'S paper on "London's Water Supply," which was announced for this evening will be read after Easter, and Mr. Dawson's paper, which was postponed from February 22nd, will be taken in its place on March 22nd.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 27.—"Judicial Reform in Egypt." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive. The LORD CHIEF JUSTICE OF ENGLAND, G.C.M.G., will preside.

It has been found necessary to change the date of this meeting from April 13 (as formerly announced) to April 27.

MAY 11.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

MAY 25.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

FOREIGN AND COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

MARCH 21.—"The Commercial Development of Germany." By C. ROZENRAAD, F.S.S., and Fellow of the Institute of Bankers.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MARCH 14.—The paper announced to be read by Sir WILLIAM BLAKE RICHMOND is unavoidably postponed.

APRIL 18.—"Modern Changes in Taste relating to Domestic Furniture." By GEORGE LOCK.

MAY 2.—"Maiolica." By WILLIAM BURTON.

MAY 30.—"Wrought Iron Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

ARCHIBALD SHARP, A.M.Inst.C.E., "Cycle Construction and Design." Four Lectures.

LECTURE IV.—MARCH 13.

Steel, rubber, and pneumatic tyres—Detachable tyres—single-tube tyres—Tubeless tyres—Valves—Inflators—Side-slip—Brakes—Saddles.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Archibald Sharp, "Cycle Construction and Design." (Lecture IV.)

Imperial Institute, South Kensington, 8½ p.m. Dr. F. S. Zaytoun, "Cape Juby and the Western Sahara."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Sanitary Institute, 74A, Margaret-street, W. Dr. J. Priestley, "Ventilation, Warm Lighting."

TUESDAY, MARCH 14...Royal Institution, Albema W., 3 p.m. Prof. E. Ray Lankester, " phology of the Mollusca." (Lecture I

Medical and Chirurgical, 20, Hanover 8½ p.m.

Civil Engineers, 25, Great George-street p.m. Discussion on papers by—1. Mr Milton, "Water - tube Boilers for Engines." 2. And by Sir A. J. Dur Mr. H. J. Oram, "Recent Trials of the M of Warships."

Photographic, 12, Hanover - square W., Capt. W. de W. Abney, "Theoretical C tions in Choosing Colours for Three Printing."

Colonial Inst., Whitehall-rooms, Whiteh S.W., 8 p.m. Hon. John A. Cockburn Australia as a Federal Unit."

Asiatic, 22, Albemarle-street, W. 4 p.m.

WEDNESDAY, MARCH 15...SOCIETY OF ARTS, Jo Adelphi, W.C., 8 p.m. Sir Marcus "Liquid Fuel."

Meteorological, 25, Great George-stree 7½ p.m. 1. Mr. F. J. Brodie, "The P Deficiency of Rain in 1897 and 1898." H. W. Yorke, "The Climate of Jersey."

Microscopical, 20, Hanover-square, W Mr. Lewis Wright, "The Projection Micr

Archæological Association, 32, Sackville-str 8 p.m.

Mining and Metallurgy, Geological Jermyn-street, S.W., 8 p.m. 1. Mr. Thomas, "Crushing and Concentration coath Mine, Cornwall." 2. John I. "Charcoal Precipitation from Auro - Solutions." 3. Mr. Sherard Cowper "Notes on the Electro-Deposition of Van

THURSDAY, MARCH 16...Royal, Burlington-house, W.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. H. O. Forster, "Influence of Substitu Specific Rotation in the Bornylamine Seri Messrs. Thomas Purdie and James C. "Rotatory Power of Optically Active and Ethoxy-propionic Acids Prepared fron Lactic Acid."

Society for the Encouragement of Fine Conduit-street, W., 8 p.m. Mr. E. Dorar "The Diary of a Sarum Worthy of t Century."

Sanitary Institute, 74A, Margaret-street, W. Dr. H. R. Kenwood, "Infectious Disea Methods of Disinfection."

Royal Institution, Albemarle-street, W., Mr. W. Poel, "English Playhouses in the Si Seventeenth, and Eighteenth Centuries." (II.)

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, MARCH 17...Royal Institution, Albemarle-str 8 p.m. Weekly Meeting. 9 p.m. Prof. Gotch, "The Electric Fish of the Nile."

East India Association, Westminster To S.W., 3½ p.m. Sir Charles Roe, "Tribes Land in the Punjab."

Quekett Microscopical Club, 20, Hanover- W.C., 8 p.m.

SATURDAY, MARCH 18...Royal Institution, Alb street, W., 3 p.m. Lord Rayleigh, Mechanical Properties of Bodies." (Lectu

urnal of the Society of Arts.

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FRIDAY, MARCH 17, 1899.

ommunications for the Society should be addressed to e Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

n Monday evening, 13th inst., Mr. Archi- o Sharp, A.M.Inst.C.E., delivered the h and last lecture of his course on "Cycle struction and Design."

n the motion of the Chairman, a vote of ks was passed to the lecturer.

ne lectures will be published in the *Journal* ng the summer recess.

INDIAN SECTION.

hursday afternoon, March 9, 1899; The L of Onslow, G.C.M.G., Under-Secre- of State for India, in the chair.

he paper read was "Leprosy in India," . A. Acworth, C.I.E.

he paper and report of the discussion will rinted in the number of the *Journal* for ch 31.

THE ALBERT MEDAL.

e Council will proceed to consider the d of the Albert Medal for 1899 early in next, and they, therefore, invite members e Society to forward to the Secretary, on fore the 8th of April, the names of such of high distinction as they may think ny of this honour. The medal was struck ward "distinguished merit in promoting Manufactures, or Commerce," and has awarded as follows in previous years :—

1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to Her Majesty the Queen.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (now Lord) Lister, P.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Prof. David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal.*

Proceedings of the Society.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 15, 1899; SIR EDWYN S. DAWES, K.C.M.G., in the chair.

The following candidates were proposed for election as members of the Society:—

Oppenheimer, Hermann L., 55, Redcross-street, Barbican, E.C.
Sanders, Henry Archibald, Somersall-hall, Chesterfield.
Wernher, Julius Charles, 82, Piccadilly, W.

The following candidates were balloted for and duly elected members of the Society:—

Brooks, Christopher P., New Bedford, Mass., U.S.A.
Butler, Joseph Margerison, 33, Dorset-street, Portman-square, W.
Clare, Harcourt E., Liverpool.
Davies, Dixon Henry, Chesterfield.
Drummond, C. J., St. Bride Foundation, Bride-lane, Fleet-street, E.C.
Fullerton, Major John Davidson, R.E., Brine Baths Hotel, Nantwich, Cheshire.
Lloyd, Edward Honoratus, 5, Crown-office-row, Temple, E.C.
Norton, Robert, Coombe Croft, Norbiton, Surrey.
Radcliffe, F. M., Liverpool.
Ward, Septimus H., Shirle-hill, Sheffield.
Writer, N. N., 7, Beverley-road, Anerley, S.E.

The paper read was—

LIQUID FUEL.

BY SIR MARCUS SAMUEL.

The subject of Liquid Fuel, although now coming into great prominence in England, is by no means a novel one. Russian petroleum has been in use for this purpose, both in Russia and America, for very many years. Its advantages, compared with coal, are well known and appreciated, and the sole obstacle to its universal adoption, has been that the supply has been insufficient hitherto to warrant arrangements being made, except in Russia itself, for its use.

In a paper of this kind, it can hardly be inappropriate to touch for a moment upon the nature of petroleum. No experts have yet been able to define how petroleum is, or has been produced, whether it is recuperated by nature as it is drawn off, or whether, as would appear from experience obtained in the Pennsylvanian fields, and in a region very far from this, namely, the Langkat territory, the yield decreases, and ceases entirely after a time. Where experts disagree, it will be admitted that it is most difficult for an ordinary layman to express an opinion that carries any weight, and, until much greater experience has been obtained, those who handle petroleum must resign themselves to the fact that territories differ almost as much as individuals do, and that whilst on some it is undoubted that the yield ceases after a time, on others it would almost appear that nature recuperates, and wells which have apparently been exhausted have yielded their treasures of oil again. At least, this has been the experience in many of the Russian territories.

Again, oil would appear to be found in layers, much below one another, the force and the pressure of gas increasing with the depth attained by boring, and it is no uncommon thing in putting down an oil well to go through strata which might have yielded a fair flow of oil, to case them off, and some hundreds of feet deeper, to hit upon a source which has spouted 50 to 60 feet above the derricks, and in spite of all attempts to catch the fountain, a vast escape of oil has taken place.

The surface indications of the existence of oil in a given territory are by no means uniform. In the fields of Baku, nothing but arid sand is to be seen. In Pennsylvania the oil fields are among the richest pasture land, whilst in Borneo thick jungle has had to be cleared before boring could be commenced. The two pictures shown illustrate a well in Baku and one in Borneo. The former shows a spouting well, and is an apt illustration of the instance I have cited.

The subject is such a large one, that I feel I must not dwell at too great length upon the preliminary stage of formation and production, yet, had these facts not been very recently brought to my notice, I should not have felt either justified, or able, to prepare the paper which it is now my privilege to read.

The incidents that I have just narrated have actually occurred in the oil fields which the "Shell" Transport and Trading Company, Limited, are developing in Borneo. It was intended, when the exploration of these fields (situated in the Sultanate of Kotei, and under the jurisdiction of the Dutch Government) was undertaken, to explore for oil which, if it proved of a similar description to that found in Sumatra, would have been specially adapted for illuminating purposes, and I must,

frankly state that the discovery of liquid in the enormous quantities in which it has found in these fields was the result er of chance than of skill. The very first bored yielded a supply of oil of a character h showed that, with very little treating, it an ideal fuel. But the mere production oil is almost its least value and least esting state. Markets have to be found, in this case almost had to be created, use it is a well-known axiom in business "Nothing sells itself," and the instance ell authenticated of a man who won a er, undertaking to stand at the corner of don-bridge and offer sovereigns for pennies out finding takers for them. So it is every commodity which is first brought use. Prejudices have to be overcome, means of using treasure have to be shown proved, and in such an article as liquid not only has transport got to be prod, but special arrangements for storage to be made, and it was also obvious that, actical success was to be obtained, liquid would have to be sold at a price which d enable it to compete with coal. *Ab* o this should be easy, when the cost of r in mining for coal is taken into account, ther with its transport from the fields e it is found to a place of shipment, and the great cost incurred in placing it on d and discharging it, and the space pied by it in the hold of a ship (this g about 45 feet to a ton of 20 cwt.), and, as this is known and realised, the danger ansport arising from the highly inflamle gases contained in Eastern coals, renders in holds and bunkers far more numerous the public are at all aware of.

is, of course, impossible to transport n bulk in steamers built for ordinary handise. Special arrangements have to nade by which the cargo is broken up sections fixed by the regulations of the Canal as not exceeding 400 tons in any compartment. It may not be out of place ne to recount as the pioneer, and even, o the present, the only exporter of oil in through the Suez Canal, the great diffies which had to be overcome in starting ransport of oil in bulk. Owing to inted and bitter opposition, almost years ed before regulations were framed under n steamers carrying oil in bulk were allowed gh the Suez Canal at all, and there was single port to which we wished to ince it, but obstacles, more or less formidable, had to be surmounted. In almost every case special regulations were devised to control what was looked upon as a very dangerous trade, yet I am happy to say that though the business has been conducted for now over seven years, not a single accident of any kind has happened, either to a ship whilst engaged in carrying oil, or to an installation. The picture now shown gives the internal arrangements of an oil steamer specially constructed to the Canal regulations. The section shows the arrangements made by the construction of coffer-dams fore and aft for isolating the oil against danger from the boilers or furnaces, which, it will be observed, in these ships are placed quite in the after part of the vessel—a practice which it is a pity is not adopted in more steamers, because the risk of accident from the breakage of the shaft is almost non-existent in this form of structure, the lead being a small one, and the shaft being under the constant observation of the engineers, since there is no tunnel. Under the regulations of the Canal Company, pumps are provided which are capable of a minimum discharge of 506 tons of oil per hour, the pumps in the ship shown being capable, in actual practice, of delivering an even larger quantity than this. To show the progress of the business, I may state that the first steamer employed in the business of transporting oil in bulk through the Suez Canal was a vessel of 4,000 tons burden of oil, whilst the largest of those employed now carry 6,500 tons, and we have three steamers in course of construction to carry 9,000 tons of oil each, or 3,000,000 gallons.

We must realise that the conditions in the production and transport of oil are different to those of coal. When once a well is drilled oil flows without any further labour. It is pumped through pipes from the well to the place of shipment, and thence into the ship, and it is discharged in exactly the same manner, not a single human being but the pump-man being visible; and in this connection a very curious incident arose. When the first tank steamer arrived in China, the curiosity of the native labourers was very much aroused when they were told that a steamer bringing something like 1,500,000 gallons of oil would be discharged from the ship without a single labourer being employed, and this is in the space of 48 hours! Some thousands of Chinese gathered along the wharf where the steamer was lying, and astonishment of the most intense description was depicted upon their usually phlegmatic

faces. The ship rapidly rose out of the water as the oil was pumped on shore through the pipes, and the manager of the wharf, accosting a Chinaman, asked him what he thought of it. "Well," said the Chinaman, "I can't make it out at all. Nobody pushes; nobody pulls; but the cargo is discharged like mad all the same," and this is, in fact, what would strike an ordinary observer in the handling of liquid fuel in bulk.

The facilities for landing and handling oil necessarily differ very much at various ports. The surroundings, too, of the tanks are essentially different, many being placed amidst scenes of natural beauty, with deep water right up to the walls of the embankment, such as Nagasaki, Japan, a picture of which I now show, where it will be seen Nature admits of the steamer lying next to the wharf, whilst in the next picture I show the installation at Kobe, Japan, where a pier had to be constructed, it being impossible for a steamer to get alongside. The next illustration shows the Port of Madras, where a breakwater of almost a mile in length has been constructed before water sufficiently deep to allow a steamer to get near of the size employed in this trade could be found, and even then, as the picture shows, a contrivance had to be constructed to connect the discharging pipe of the steamer with the breakwater. In spite, however, of these drawbacks, it is found that a steamer can easily discharge into the tanks, placed at one mile distant from the ships, at the rate of fully 200 tons an hour. I should also like to show a plcture of the island of Freshwater, where the business for Singapore is conducted. The Government, not understanding how free the business was from danger, would not allow the tanks to be erected on the island of Singapore itself, and compelled us to go to the picturesque spot shown, and, as a final example of the progress of liberal ideas, I show the installation at Bombay, where permission to land the oil was only given some two years ago, and after experience had shown the immunity from danger attending the transport of oil in bulk, and it will be seen that these tanks are placed almost in the middle of the shipping, railway sidings have been taken right up to them, whence oil is pumped into the tank waggons for conveyance all over India. I will show a train of tank waggons, specially constructed for the India service, and these are very interesting, inasmuch as they are the only tank waggons which are entirely welded by electricity, and not a single rivet is employed in them. This picture shows the bodies of waggons ready for shipment. The next sl a waggon completed, as used actuall India, covered by a corrugated iron sl allowing air to freely circulate round the and so protect it from the effects of the To complete the history, I show an up-cou station at Ranaghat in India, and bullock carts, showing how oil is distrib to the shops at Colombo.

It is necessary to go into these de in order that it may be understood wha enormous future lies before this fuel, even only depended upon its relative cost comp with coal, but when we come to the colla advantages it enjoys, the benefits of usin as compared with coal, are simply whelming.

It is unfortunate that it should be so one cannot fail to recognise the fact tha calls for purposes of war must take pri of those of peace, and the first advantage to vessels of war, especiall torpedo boats, in using liquid fuel, as pared with even the best coal, is the e absence of smoke arising from its employm When combustion is complete, not a tra smoke issues from the funnel of a vessel it. How important this is to torpedo b the least initiated can understand, but it i less so to cruisers, or even to battles which, when using liquid fuel, could shado enemy's fleet without being detected.

I show, in this connection, a pictu the steamship *Trigonia*. In September the *Haliotis*, a sister to this steamer, brought round from her port of constru (Newcastle-on-Tyne, where she was bui Messrs. Armstrong and Company) to Thames for exhibition purposes, her furn being fitted with an arrangement for bu liquid fuel. They are, however, avai for coal in the ordinary way, if requ it being possible to make the necessary al tions for a change of fuel in a very few h From the bunkers, which are so constru that they can be used for either oil or coa oil is pumped to a service tank abov boilers, whence it flows by gravity to a d at the furnace doors, where, by means steam jet, it is pulverised or broken into s The diagrams now shown will illustrat arrangements made for the utilisation of this system, and I might say that a vast is open for the ingenuity of engineer devising other methods for the utilisati oil—in fact, almost daily discoveries are

[ma]de of means by which liquid fuel may be [ut]ised to greater advantage than any yet [dis]covered, and it would surprise me very [mu]ch if, with practice, the methods employed [do] not continually improve. Under the system [ado]pted in this ship, steam is used to spray [the] oil, but this is certainly not the most [eco]nomical method, and already a system has [bee]n found, invented by a Dutchman, called [the] Kloos System, which entirely dispenses [wit]h the use of steam. The diagrams now [sho]wn will illustrate this system.

[O]ne main point of difference between the [bur]ning of coal and liquid fuel is that, while [coa]l remains quietly in its place until it is [bur]nt, liquid fuel would offer too small a [sur]face to the air when lying in a tank to [bur]n with so much heat as is required. It [ha]s, therefore, to be sprayed out in small [par]ticles to augment its surface. If, how-[eve]r, the oil is sprayed mechanically, the [rus]h of cold air chills the spray, and many [of t]he small drops reach the funnel before [com]bustion has taken place, thus producing [smo]ke and soot. By heating the air well [abo]ve the burning temperature of the oil, [bef]ore it reaches the spray, this is remedied, [and] combustion takes place freely.

[I]n the heated air system, the oil is forced [at] about 50 lbs. pressure through a Körting's [spr]ayer into the furnace. In this sprayer the [cur]rent of oil has to pass a screw thread, [wh]ich gives a rapid turning motion to it, so [tha]t the centrifugal force causes the liquid to [fly] out in dust. The air is brought by a [sli]ding plate at the back of the furnace, [retu]rns along cast-iron ribbed plates which are [hea]ted by the flames above it, and meets [rec]tangularly the current of fine sprayed-out [oil], the air being heated to about 500° Fahr. [As] the hole in the sprayer through which the [oil] is injected is under 1-16th of an inch in [dia]meter, the liquid must be well filtered, and [to] assist the centrifugal force in spraying it [out] in fine particles, the oil is heated to about [...]° Fahr.

[I] am well aware that it is alleged, as a [dra]wback to its use in the British Navy, that [liqu]id fuel has, so far, only been produced in [Ru]ssia and America, but the territories in Borneo [are] under the flag of a nation that has ever been [frie]ndly to Great Britain, and is scarcely likely [to] be hostile, and, at all events, provided [am]ple storage arrangements are made, such a [sto]ck of liquid fuel could be provided in our [Ea]stern ports as to render the naval authori[tie]s practically independent of renewed supplies if, unhappily, hostilities broke out. Neither must the fact be lost sight of that, if oil has been found in the Dutch Indies, there is no reason why it should not be found, too, in territory under British rule. The production in Burma is already of an important character, and, as in most things, we shall see the demand create the supply.

Experiments have demonstrated that the calorific power of oil is almost as two to one compared with Eastern coals. This is in ordinary marine boilers, but in launches the economy in its use is very much greater, and in one craft, used in Hongkong, repeated and carefully checked tests have shown that, whilst the consumption of coal was 7 lbs. per minute, the consumption of oil was only 2 lbs. per minute. The pressure of steam realised by 7 lbs. of coal was from 96 to 105 lbs., whilst that raised by 2 lbs. of oil was sustained at 116 to 120 lbs. The speed realised in the launch under coal had never exceeded 9 knots, whilst under oil a speed of 10¼ knots was readily maintained.

It is well known that for locomotives great advantages are experienced in using liquid fuel as compared with coal, and the economy is equivalent to the ratio of 1 ton of oil to 2½ tons of coal, and, in addition, it has been found that, whilst a locomotive burning oil will maintain the same head of speed up the steepest gradients, the same feat cannot be accomplished upon coal, where the mere firing of the boiler with every renewal of fuel serves to damp the furnace, whereas every injection of oil, going into immediate combustion, tends to raise and maintain the speed.

One of the first men in England to recognise the great advantage of using liquid fuel on locomotives was Mr. Holden, the engineer of the Great Eastern Railway Company, on which line, in spite of the cost of liquid fuel compared with coal, most of the express trains are run by that fuel to-day. The diagrams shown illustrate this system, which is the best for this purpose yet invented, and by its means steam is readily obtained upon every description of boiler. The next diagram shows its application to a Lancashire boiler, which form is still a favourite among mill and factory owners, and the adaptation of the Holden system to this type of boiler has been very successful. I believe a great future exists for this fuel in smelting works for metallurgical purposes—the intense heat which it is capable of generating, reducing the most stubborn of ores.

Great economy is effected also in the

stowage of oil compared with coal. We have found, from careful experiment, that the Borneo oil stows in a space of only 38 feet to the ton, and, deductions from the figures which I have furnished, as compared with coal, will show the much longer duration of supply in a given space of liquid fuel than of coal, and the consequent less frequent stoppages for filling tenders, or of transporting to them the respective fuels, since it is manifest that if oil is used, only one ton is to be carried up-country, as against at least two tons and a half of coal. I cannot help thinking what enormous possibilities develop in countries where coal is at famine price, as on the projected line from Cairo to the Cape, through the introduction of liquid fuel.

In this connection, and as showing the great progress that has already been made in the use of liquid fuel, and its widespread application, I show a slide which represents a later express engine of the Great Eastern Railway, designed by Mr. Holden last year. It has drivers 7 feet diameter and cylinders $18\frac{1}{2}$ in. by 26 in., and a boiler with 1,292 square feet of heating surface and a working pressure of 160 lbs. per square inch. The tender, it will be noticed, is of a particularly neat design, and is capable of carrying 2,790 gallons of water, 715 gallons of liquid fuel, and 30 cwt. of coal. It is provided with a water-scoop for replenishing the tank whilst running. The total weights in running order are—engine $49\frac{1}{2}$ tons, and tender 36 tons: total, $85\frac{1}{2}$ tons. The oil firing arrangements embody a number of ingenious details; among them the supply of hot air for combustion from a series of cast-iron heaters placed around the inside of the smoke-box, the air being drawn from the front through the heaters to the burners by the exhausting action of the steam jets used for injecting the oil fuel. The latter is warmed before leaving the tender in a cylindrical heating chamber, through which the exhaust steam from the air-break pump circulates.

The next slide shows the footplate and interior of the cab of one of these engines. The regulation of the oil supply is effected by a neatly designed gear attached to the cover or hood of the ordinary fire-door. These engines have been specially constructed for running the fast Cromer service, on which they have rendered a good account of themselves during last summer.

The slide now shown represents a small four-coupled shunting engine, of the London and North-Western Railway, fired with oil-fuel on Mr. Holden's system. It carries the oil be the footplate in a long reservoir, from whe the burner lifts it by suction. Engines of type are used in the Liverpool Docks.

Next is an engine of the Metropolitan R way for service on the Underground in Lond

One of the suburban engines of the West of France is shown in the next slide. working between Paris (St. Lazare) and Germain.

The succeeding picture shows the Vienn Paris express, with a heavy Golsdorf compo engine in front, burning oil fuel on Hold patent system. The train is shown standin St. Anton, just prior to entering the Arlb tunnel, six miles long. All trains, goods passenger, passing through the tunnel are fired with oil fuel on Holden's system.

I have now a view of the Coronado expres the Southern California Railway standing at Diego, with an oil-burning locomotive in fr Oil fuel is now the common fuel in South C fornia, immense deposits being worked at Angeles.

The next slide shows a winding plant mining machinery with portable locomo type boiler fired with oil. This fuel adopted here on account of the cost of tra port, only one ton of oil being carried inst of two tons of coal.

The last slide shows a traction engine, 40 dicated horse power, for South Africa, runn between Umtalla and Salisbury, burning fuel. Coal being expensive, and wood sca oil fuel has been used here.

Nothing can give a better indication t these slides of the widespread use that li fuel has already attained, and it is quite c that in countries where it can be put down it can unquestionably now from Borneo t ports east of the Suez Canal, at prices w will enable it to successfully compete coal, its use is quite certain, and that in immediate future.

The advantages of the use of liquid fu steamers, however, are even more man than in its employment on land. None those concerned in the actual manageme steamers know what trouble and anxiety a from the employment of what is known as "black element," namely, the stokers. the use of liquid fuel the services of these are almost entirely dispensed with, becaus flows by gravitation from service tanks pl well above the boilers, direct to the furna The expansion and contraction caused by frequent opening of the furnace door

...y avoided, and the life of a boiler, con...ntly, greatly prolonged. No ashes are ... and the strain and distress to firemen of ...ng these overboard before commencing ... watch is entirely saved, and no grit (so ...y in its working to delicate parts of the ...es) is created. I fear it is only a practical ... who will realise how much this means.

... anyone who has seen the almost in...n manner in which the large crew needed ...torpedo-boat or destroyer are berthed, in ...quence of having to stoke the enormous ...s used upon these craft, the fact that ... the use of liquid fuel the crews of these ...s can be reduced to less than half of ... now necessary is, in itself, an argument ...verwhelming that, were this its only ...tage, it would suffice to compel its intro...on into this class of vessel by those in ..., but, when it is borne in mind that men ...pedo craft literally carry their lives in ... hands, depending solely on the speed of ...essel, and not upon her armament, it is ... that a great step is attained when the ...carried upon these vessels is reduced.

... can be carried in spaces which it is im...ble to utilise in any other way, and espe... in such craft as torpedo-boats, where the ... of the vessel under water renders the ...ing of stability a difficult problem. Oil ...d in the bottom of the steamer, below the ...-line, would be impervious to shot, and, ... system of service tanks patented by Sir ...scue Flannery, as oil is pumped out of the ...st-tanks of a steamer, water can readily ...ken in to replace it, because if the mix...s put into a service tank, and allowed to ..., water is quickly precipitated to the ...n, and can be drawn off, the oil remain...eing pumped pure into the second service ... whence it flows to the bunkers, and it ...eadily be conceived how many spaces ... lost in vessels can be utilised for the ...ge of oil, allowing a much greater weight ...mament or quantity of cargo to be carried ...ace now used for bunker purposes only, or ...ntirely through being too small or in...sible for the storage of coal. The import... of the new departure has been promptly ...nised by Lloyds, who have issued regula... allowing liquid fuel, having a flash point ...er 200° Fahr. to be carried in steamers' ...st tanks, and this will greatly facilitate ...neral use.

... much longer time that a vessel ...ped with liquid fuel can keep at sea is ...a factor which must not be overlooked, and, provided relays of supplies are furnished at ports not too far apart, the carrying capacity of an ordinary merchantman is increased by some hundreds of tons, dependent necessarily on the size of the vessel, whilst the saving in time in taking in oil instead of coal as bunkers can be best estimated when I state that oil can easily be put on board at the rate of 300 tons per hour, and this without the slightest dirt—a great characteristic of the Borneo oil being too that it is almost odourless.

The experimental stage in the burning of liquid fuel, as stated at the commencement of this paper, has long since been passed. The uses for it in Russia itself are innumerable, and the latest statistics show that no less than 7,000,000 tons per annum are consumed in Russia for liquid fuel alone. Lately it has been largely adapted for naval purposes as well, whilst for many years the steamers navigating the Caspian Sea have used it exclusively. There are no less than eight steamers at present engaged in the Eastern trade which are fitted for it, and the results attained have answered the expectations of their owners beyond their most sanguine anticipations, whilst large numbers of vessels are under construction expressly for the use of liquid fuel, and a great number of steamers hitherto burning coal are also being altered. In the Far East tanks have been erected at ports ranging from Yokohama to Suez, including all the Indian ports, whilst cargoes of the Borneo oil have also been landed at the principal ports, and 4,000 tons is on passage to London. Under the advantages which I have enumerated it will be understood that it is rapidly going into general consumption. In Europe the Russian, the Italian, and the German navies have partially adopted it, and it will be a curious circumstance if, with the great engineering skill available in the British navy, our naval authorities should not also see their way to use it to advantage in the immediate future.

DISCUSSION.

Admiral SELWYN said he had been trying experiments for many years with regard to the use of fuel for naval purposes, and was now prepared to prove that fluid—not liquid—fuel was the real solution of the question; he said fluid, because he considered liquid fuel alone was quite obsolete; they must use gaseous fuel very largely, and while all gases were fluid, many which would be used in future were not naturally liquid. Principal amongst these was the nitrogen of

the atmosphere as well as its oxygen, and the hydrogen of steam as well as its oxygen. All these were capable of exothermal action in a very high degree, under certain circumstances as had been proved by Mendeleeff and Professor Dewar. The result of their experiments was to show that when these gases were raised to the temperature of the electric arc, an enormous amount of heat was given out by their combination. By his own experiments in 1886-87, he had shown how the efficiency of the British Navy could be trebled, and the important point was that in our own country we had a more reliable source of heavy oil—not petroleum—than existed either in the United States or Asiatic Russia, and it could be produced at a much lower price, considering its evaporative value, than coal. He congratulated Sir M. Samuel on his paper, and hoped it would prove useful; but he would remind them that whenever a ship got run aground, some of the fuel had to be thrown overboard, and then they wanted it to sink to the bottom, not float round the ship. There were also dangers of fire on board ship, any increase in which would lead to higher rates of insurance. He had come to the conclusion, from his experience, that light oils, which only evaporated 17 lbs. of water per lb. of fuel, ought not to be used for naval purposes, whilst with the heavier oils more than three times that amount of duty could be obtained. This had been done since 1865, and with this heavy oil there was no danger of enhancing the rates of insurance. By burning the hydrogen in the steam you added 7 units of heat to that obtained from the oil itself, and if you could get the nitrogen to burn you added another 22 units, and, going on in that way, you would reach a point where you would be able to drive a large cruiser round the earth in 40 days, and she would still have enough fuel on board to take her across to America and back. He hoped, therefore, that the chemical idea would not be dropped; and also that the question of utilising our own shales would be borne in mind. There was an enormous bed running from Portland right across to France, and enough fuel could be obtained from that by convict labour at Portland as would keep the whole navy going. There was another seam, 600 feet thick, right across from the Humber to the Wash, where it split, and one portion went into Northumberland, where he was told it had been found 40 feet thick, and another portion went to Hanover. Some of these shales, when properly treated, would yield from 60 to 120 gallons to the ton of heavy oil.

Dr. DVORKOVITZ said when he was in Baku, in 1878, he found the same prejudice against the use of petroleum as still existed in many parts of Europe. At that time a small portion of the crude oil was used for burning, and a still smaller portion for lubricating, and the remainder had to be let run to waste. No one, at that time, would dream of taking it in pipes for the purposes of fuel. Russia, however, had set the example, and last year she used 7,000,000 [illegible] for fuel; in 1878, only half a million tons were [illegible]duced. Now all the passenger steamers on the [illegible] and the Caspian used oil. He introduced it i[illegible] neighbourhood of Moscow in 1884, on his [illegible] from Baku, but with difficulty. He asked a frie[illegible] his, who had a large manufactory, to try it, but [illegible] his engineers were consulted, they were afrai[illegible] whole works would explode. The same factory [illegible] used 5,000,000 poods a year. It was a mistake to [illegible] sider the question of liquid fuel simply from the [illegible] of view of its calorific power, because it poss[illegible] enormous advantages in other respects over [illegible] particularly in the matter of storage, saving of l[illegible] in handling, cleanliness, and storage on board [illegible] Sir Marcus Samuel had referred to the importa[illegible] the matter to the British Navy, and, no doubt [illegible] British Government would have to pay attention [illegible] seeing what was being done by the French and [illegible] navies. But, after all, he was a man of peace, a[illegible] looked more to the use of liquid fuel for passe[illegible] steamers. By its means, a saving of time to [illegible] extent of one-fourth might be effected, and i[illegible] could go to New York in four days instead of fi[illegible] was worth doing. With regard to shale oil [illegible] believed the Scotch shale producers worked [illegible] hard and did not produce any dividend by prod[illegible] a burning oil for which they charged a high price, [illegible] as would never be paid for fuel. There was no [illegible] the Shell Company had got one of the largest [illegible] in the world, and, seeing the energy with [illegible] it was worked, there was no doubt that liqui[illegible] would soon be in general use, and he though[illegible] M. Samuel had done a public benefit by brin[illegible] the matter forward.

Mr. W. F. LANE said he had been connected [illegible] the petroleum trade for many years, and was nat[illegible] much interested in this paper. Practical me[illegible] business could not be expected to keep abreast o[illegible] of science for one reason, because they had to [illegible] their way as they went on. The production, m[illegible] facture, and merchanting of petroleum present[illegible] many varied questions that he could but admi[illegible] skill and energy with which Sir M. Samuel had [illegible] with a problem which was by no means so sim[illegible] it looked. The first requisite to the introducti[illegible] liquid fuel was that the consumer should be assur[illegible] a constant supply, as required, at a reasonable [illegible] but the vast organisation which the Shell Compan[illegible] created, which embraced storage at every port i[illegible] East from Aden to Japan, formed a suff[illegible] guarantee that the supply would be equal to [illegible] demand. They had been very fortunate in discov[illegible] a supply in Borneo, which was unique in char[illegible] and seemed to be ample for the wants of the Eas[illegible] beyond that there was a vast activity going [illegible] many other directions, and the comprehe[illegible] organisation of the company would provide [illegible] supply being forthcoming wherever it was requir[illegible]

. F. W. FLETCHER said as he had had some ence in the use of petroleum furnaces for melting ses and as muffle furnaces, he should like to n what were the advantages and disadvantages ose he used. He considered petroleum furnaces useful for melting alloys of the precious metals, especially those containing silver and copper, as was considerably less oxide formed during the ss, and these oxides were the chief cause of nd castings and unworkable metal. One great tage in this class of furnace was that you could the heat of your furnace to something near the ng-point of the metals you wished to melt, before ng in the pot containing those metals, so that process of melting commenced almost imme- y, thereby saving a considerable amount of time, at the same time preventing, to a large extent, xidation of the metals, which occurred when a furnace was used and one had to put cold fuel l the pot; though he considered the absence of xious gases in the petroleum furnace one of its advantages. A furnace that was brought to his e about 1878 was one in which crude petroleum used in conjunction with a steam blast. It ed splendidly at times, but occasionally the injector-pipes got stopped up and caused con- able trouble, and the noise was so great that the who worked it seemed afraid of it. A different of petroleum ejector was brought to his notice four or five years ago, in which the force of the from the mains (which averages 45 lbs. per e inch) was used to cause a pressure behind the leum, and so forced it through the small ejector- of the burner. The reservoir consisted of a l tank, in the top of which was a pipe connected the water-supply, and passed very nearly to the m of the tank. Another tube passed from the f the tank to the burner. The tank was then with ordinary paraffin oil, and when required the r was turned on, and the supply of oil was nuous; but still the great difficulty was the ing of the small holes of the burner, which to be continually cleared with a piece of This would be a very useful arrangement for a l muffle furnace, especially if the defects men- d were rectified. Another furnace that he had for small experimental work, was one in which oline was used with an air blast. This might ar at first sight a very dangerous affair; but if a er vapouriser was used it was perfectly safe. For nelling and certain porcelain work it was in- ible, as the open flame without a muffle could sed without gassing the work, as it is called; is altering the colour, as was frequently the case e coke or gas was used, and there was a slight in the muffle. The temperature attainable by e furnnces was far above the melting point of gold, and therefore could be used for all kinds nelting and muffle work. While speaking of aces for small work, he might mention a material h he had used for making or lining small furnaces with very good results. It was a certain kind of asbestos, termed "asbestic;" it was far preferable to fire-clay or the baked clay of which muffles and small furnaces were generally made. He added about 10 per cent. of good plaster to it to make it bind well, and a larger proportion for the outside, or when a smooth surface was required. It could be easily packed into an iron case, or even a wooden one, being a good non-conductor of heat, and could be built up to any shape required, either for a muffle or an open furnace, and stood a high temperature remarkably well. The asbestos it contained gave a rough surface to the interior of the furnace, which helped to break up the flame as it passed round the pot or muffle.

Mr. LOWICK said some years ago some experiments were made with the burner that was used to take the *Baku Standard* across to America, while on the other side of the ship there was an ordinary marine boiler; the boiler using oil had the two wing furnaces bricked up, and only the centre one was used. After both boilers had been running some time, the steam was turned off from the one using coal, and the whole of the work was thrown on the one using oil. For the first minute or two the pressure fell, but only a few pounds, and after that it kept the same machinery running as well as the other had done, and that was continued for about a quarter of an hour. The other boiler had three furnaces and a forced draught.

Mr. R. TRAILL said the firm in which he was engaged had been experimenting for many years to find out the best form of burner and furnace for liquid fuel. In the long run, they found a burner which did very well, and had since fitted up a number of steamers for the Caspian and Black Sea, and other parts of the world. He thought Admiral Selwyn, in speaking of the chemical action of gaseous fuels, had hardly put the matter fairly. No one had yet told them the actual value of liquid fuel; the calorific value of the Borneo oil was 24,000 units, which, as compared with 15,000 for the best Welsh coal, gave an advantage of about 30 per cent., but beyond that, in the burning of liquid fuel the combustion was so perfect that the practical effect on the evaporation of water, compared to coal, was as two to one. Under ordinary conditions, with a marine boiler, 1 lb. of oil would evaporate 15 lbs. to 16 lbs. of water, whilst with the best Welsh coal the result was about 8 lbs. He had recently had to make a list of the advantage of liquid fuel, the oil chiefly experimented with being one obtained from Borneo, which could be used in the crude state as it came from the wells, and which was far superior to shale oil for the evaporation of water. Amongst the advantages were the absence of acids or residues, which saved a great deal of time and work in cleaning and scouring the tubes, and a great saving of labour in handling on

board ship; no coal trimmers were required. Then there was a saving of room, thus adding to the carrying capacity of the ship, and the oil could be carried in places where coal could not, for instance, where water ballast was carried. The wear and tear of the boilers was reduced to a minimum, owing to the absolute uniformity of temperature in the furnace. Steam could be slightly raised by a small number of burners, and in going through the Suez Canal, or when steaming slowly, the blowing off of steam might be avoided in the same manner. The consumption of fuel could be regulated to a nicety. The only thing requisite to enable shipowners to use it in preference to coal, was the certainty of a sufficient supply at a moderate price. The necessary alteration would involve but a very small expenditure.

Mr. ROBERT BRUCE said he had not the slightest doubt there was a great deal to be gained by the use of liquid fuel; but he regretted that no proper comparison had been drawn between the results obtained by it and those got from a modern marine boiler. They had been told that an ordinary boiler evaporated 8 lbs. of water per lb. of coal, but a great deal more than that could be done. There were steamers running now which were developing an indicated horsepower with $1\frac{1}{2}$ lb. of coal. He knew Mr. Kloss, of Amsterdam, and that he had obtained very good results; but he was improving all the arrangements continually, and no doubt in future he would effect a still greater economy. In working the oil jets a considerable amount of steam was used, which meant coal or other fuel to generate it. What was required was an increased supply of air, so that the combustion of the fuel would be more complete than it was with the steam-jet. There were many points in the paper which could be much further elucidated if time allowed; and he hoped the comparisons made between liquid fuel and coal would be received with some amount of caution.

Admiral SELWYN said, in reply to a remark by a previous speaker, that so long as the Scotch shale companies tried to compete with Nature in the formation of light oils, it was not very likely they would be successful, but when they gave that up and made heavy oil, they paid dividends. During his 33 years experiments, he had only used old marine boilers or Cornish boilers, but every pound of oil he used was carefully measured, and so was the water actually evaporated. He evaporated 22 lbs. of water with an old marine boiler, and with a Cornish boiler, 48 lbs. The common theory was that you could not get more heat out of the hydrogen in the steam than you gave to make it into steam, but this was absurd. When you burned hydrogen, you did it at 3,000°, for at a lower temperature it would not burn. Messrs. Johnson and Matthey, whom he had taught how to use liquid fuel, now melted platinum like lead, in large crucibles containing 100 lbs.

The CHAIRMAN said, on the whole the discussion went to support what they had heard in the about the great value of liquid fuel. He w sufficiently scientific to appreciate all A Selwyn's remarks, but they were very va and particularly his reference to the possibi utilising our own stores of shale. They were indebted to Dr. Dvorcovitz for his informat to what was been done in Russia, where th knew liquid fuel had been used for a long Some thirty-three years ago, when travelli Persia, he heard a great deal of what was done Caspian, and came home, as a friend told him oil on the brain. Mr. Bethell, who had ext works at the Docks for creosoting timber, too down there and showed him a tank with the oil from the creosote works, where a man simply a tap and the oil ran through a nozzle, and a steam distributed it over a mass of incandescen and so kept a continuous heat. He thought th difficulty was solved, and expected to see in a time half the steamers running with liquid fuel i of coal. Next time he saw Mr. Bethell, howev told him that coal had got much cheaper, and h discontinued the use of oil. He noticed a good shipowners present, but they had maintai judicious silence, which was perhaps partly exp by Mr. Lane. He said it was simply a quest £ s. d., and if shipowners could see their w make an extra 1 or 2 per cent., and could feel c that liquid fuel would be found at the various p which they called, and that they could run 30 on board in an hour without dirtying their ship carry more cargo, and so on, it would not b before liquid fuel was adopted. At present the a good deal of hesitation; they were not quite c that the supply would be sufficient and perm They were indebted to Mr. Traill, who repre the Wallsend Slipway and Engineering Com for the information he had given as the res very careful experiments. He would ask Sir M Samuel to inform the meeting as to the supp oil available.

Sir MARCUS SAMUEL, in reply, said he little alarm when Admiral Selwyn said the f advocated was better from the underwriters' p view than liquid fuel. Probably he did not that the London underwriting world was l represented that evening, and he might have ca grave injury to the company which he repres However, he felt that those gentlemen had suc sense that they would never think of putting premiums on ships burning liquid fuel. Althou could not aay they were charged such low pre as they ought, still the Shell Line steamers placed almost on a level with mail steamers, present he did not know that they had much t plain of, though in the beginning prohibitive were asked. The Chairman was a man of pr common sense, and he would ask him whether body of gentlemen as the directors of the Shell

would invest something like two and a-half s sterling in a "will-o'-the-wisp" undertaking? oduction in their field was already very large, would stake his reputation that, to the extent e millions of tons, a year at any rate, the field alone could furnish liquid fuel for the world. He was anxious that this should be ghly well known. The field in numerous places area of 60 miles had been tried, and the same tion of oil had been found, and, there- il would be forthcoming to meet any probable l. Still, oil production was, in a sense, a will visp. Whilst some few men had made millions it, it had been the cause of ruin to innumer- xplorers. From the days when Sir Walter wrote "The Golden Butterfly" to the present, had been men who found oil only to lose it But the finding of the oil was the least part vork; it was the enormous expense and diffi- of organising the means of distribution which nerally the stumbling block. The company he nted opened their arms to everybody; they did ave a monopoly. All supplies would be e, and the company were ready and willing l means of transport and distribution. It ecently undertaken the distribution of the m the vast fields of the Moera Emin ny, who had a property quite as rich as that by the Shell Company. It was practically d by the Standard Oil Company of America, Dutch Government interfered, and it was now led and would be managed by the Shell ny, to whom the prejudices of the Dutch ment did not extend. There was, therefore, assurance for the commercial world that all the ired would certainly be produced. Roumania w producing immense quantities, and during t month proposals had been made for laying a e from the fields to Castenji, so that immense s at a reaaonable price were assured. It was greatest interest to the world in general, and Shell Company in particular, that supplies be found, and there were evidences appearing of new oil fields hitherto unknown. Galicia rosny were almost unexplored; they were vy oils. He was very pleased to say that . Armstrong were taking an interest in estion; they had requested the company to them with a large supply of oils, with which tended making exhaustive experiments, con- t on the success they had already attained. yone who knew that firm, it was almost a tee of success when they took up anything. Borneo oil was absolutely limpid and contained h whatever, so that it was impossible it could e tubes. The difficulty was, it was so light when spread by the steam jet it dispersed too , but that would be obviated by the use of Mr. Kloos's plan appeared to offer a solution; nyhow, all these questions of detail could lly be solved by men of science.

The CHAIRMAN then proposed a vote of thanks to Sir M. Samuel, which was carried unanimously; and the meeting adjourned.

Miscellaneous.

COMMERCIAL EDUCATION.

The Special Sub-Committee of the Technical Education Board of the London County Council have reported to the Board, and the Report has been published. Among other points dealt with in the Report the following may be specially mentioned:—Interest of London in the question—different views of commercial education—its function—the kind of education that is needed—principal points in which our present systems of education can be improved so as to give a better training for commercial life. The following are some of the recommendations of the Committee which have been adopted, as summing up what appear to them to be the results of their inquiry:—

That further and better provision for commercial education is urgently required in London; and that it should be the object of the Technical Education Board, so far as its resources permit, and so far as is consistent with due regard to other claims, to assist in supplying this need.

That the commercial education required is of several distinct grades, and must be adapted to the different needs of many distinct groups.

That, to meet the needs of those who enter business offices about the age of 14, day continuation schools are reqnired, which should give a two years' course of training specially adapted for commercial life; and that some of the Board's junior county scholarships should be tenable at such schools.

That it is desirable that there should be in many of the public secondary day schools in London of the second grade departments devoting themselves, primarily and avowedly, to the preparation for commercial life of boys who will leave school at 16; that in such departments, while a good general education should be given, special attention should be devoted to modern languages, in such a way as to turn out pupils able to speak and correspond fluently in at least two modern languages; to the teaching of arithmetic, so as to secure perfect facility in the use of the metric system; and to ensuring a good general acquaintance with the commercial geography of foreign countries.

That negotiations be entered into with a view to the development of such a department in one or more of the existing public secondary schools of the second grade.

That it is desirable that there should be provided in London in at least one public secondary day school of the first grade a department devoting itself primarily and avowedly to the preparation for business life of boys leaving school at 18 or 19; that the curriculum of such department should not lead up to a classical of mathematical career at the Universities, but should qualify its pupils either to enter the higher ranks of commercial life or to pursue an advaneed course of study in the economic and commercial faculty of the new London University, or in other institutions of higher commercial education.

That negotiations be entered into with a view to the development of such a department in one or more of the existing public secondary schools of the first grade.

That it is desirable that a certain number of intermediate county scholars should hold their scholarships in the commercial departments of second grade and first grade schools, when such departments have been established.

That it is desirable that full and express recognition should be given to higher commercial education in the re-organisation of London University; and that it be referred to the special Sub-Committee of the Board, dealing with the University, to consider whether it would not be wise to urge upon the Commissioners the establishment, from the first, of a separate faculty of economic and commercial science; the provision of endowed professorships in the various subjects of higher commercial education; and such arrangements as will facilitate and encourage those designed for or engaged in the higher ranks of business to take advantage of university teaching.

That it is desirable that a certain number of senior county scholars should go through a university course in subjects of higher commercial education; and that, in addition, travelling scholarships be offered to enable teachers of some experience to study in higher commercial institutions abroad, in order to qualify themselves as teachers of commercial subjects.

The other recommendations deal with the best mode of carrying out the recommendations.

The Appendixes to the Report are:—1. Evidence; 2. Report of Mr. Fishbourne's Interviews with Employers, containing an expression of their views on the subject of Commercial Education; 3. Information respecting Foreign Commercial Schools; 4. Select Bibliography of works relating to Commercial Education; 5. Information supplied by Head-masters and Principals of Public Educational Institutions on the subject of the existing provision for Commercial Education in London.

JUTE AND HEMP MILLS IN INDIA.

According to information received through the India Office, the *Board of Trade Journal* says that there were in India, excluding one jute mill closed early in the year owing to damage by earthquake, 33 mills working jute and one mill working hemp at the end of 1897-98, and employing a daily average number of 95,930 persons, i.e., 62,247 men, 17,000 women, 5,740 young persons, and 10,853 children. The mills contained 13,615 looms and 274,907 spindles. The nominal capital of such of the mills as are worked by joint stock companies is stated in the returns at a little over Rx. 4,6[illegible] but the figures are not complete, some of the mills (privately owned) having furnished no returns of capital. Probably about Rx. 250,000 or Rx. [illegible] may be added to the total on account of these.

All but two of the mills are in Bengal, most of them in the vicinity of Calcutta, and one in the French settlement of Chandernagore. All of these are owned and worked by joint stock companies, except the Alipore Jail Jute Mill, which belongs to Government, and the Hastings Jute Mill at Rishra, which is privately owned. Of the two not in Bengal, one (a small one) is at Vizagapatam (this being the mill which works hemp), and the other at Cawnpore. Both of these are privately owned.

The progress of the industry during the last ten years is illustrated by the increase shown in the figures below in the number of mills, looms, spindles and persons employed. It will be observed that while the number of mills has largely increased in this period, their working capacity has been much more largely augmented. In the last two years there has been a marked addition to the number of mills and to their working capacity.

Year.	Mills.	Looms.	Spindles.	P[illegible] em[illegible]
1888-89	26	7,819	152,667	[illegible]
1889-90	27	8,104	158,326	[illegible]
1890-91	27	8,204	164,245	[illegible]
1891-92	27	8,695	174,156	[illegible]
1892-93	27	8,976	181,172	[illegible]
1893-94	28	9,590	192,688	[illegible]
1894-95	29	10,048	201,217	[illegible]
1895-96	29	10,579	216,139	[illegible]
1896-97	32	12,784	258,154	[illegible]
1897-98	35	13,615	274,907	[illegible]

JEWS IN PALESTINE.

The United States Consul at Beirut, in an in[illegible] ing report which he has recently addressed [illegible] Government, says that in view of the impetus g[illegible] the Zionist movement by the Second Zionist Co[illegible] held at Basle in September last, and also [illegible] Palestine journey of the German Emperor, the [illegible] status of Jews in Palestine becomes a ma[illegible] general interest. Out of a total population in Pa[illegible] of some 200,000 souls, about 40,000 are Je[illegible] against 14,000 twenty years ago. In Jerusalem [illegible] are 22,000 Jews, half of whom have immigrate[illegible] Europe and America, and are called Aschkena[illegible]

ish them from the Oriental Israelites, the lists. Nine hundred and sixty families, ing about 5,000 souls, inhabit the 22 Jewish in Palestine, which have been founded and ed by Europeans, ten by Baron Edmond de hild, representing the Alliance Israelite Uni-, the rest by the Jewish Colonisation Associa-d by the Odessa Company. The idea of ng in Palestine homeless Jews scattered all e globe, was championed in the forties, but ndifferent success. In the eighties, however, migration of Jews into Palestine assumed ant proportions. Of the 22 present colonies the Memorial" is the largest, supporting more 00 souls. It boasts a school with five teachers, gogue, &c., and 4,000 acres of land under tion, on which are grown fruit (chiefly grapes) ulberry trees, the rearing of silk worms being a industry. The "First to Zion" is another ant colony owning 2,000 acres of land. Some wo-storied stone dwelling-houses greet the eye approaching stranger; also a schoolhouse with ew library, a synagogue, and a hospital. One five hundred thousand vines, and 25,000 l, orange, and mulberry trees, belong to this , which also possesses famous wine cellars. Hope of Israel," a mile below Yafa, in the of Sharon, is, perhaps, best known for its tural school, in which one hundred or more are taught gardening. Recently, a high school wish girls was established in Yafa. The "Head Stone" amid the hills beyond Tiberias, with capped Hermon in the background, is another rous Jewish colony in Palestine. Being near urce of the Jordan, water is plentiful, and its on high up above the level of Lake Gennesareth s fair climatic conditions. In the "Door of " dairy farming is profitably followed, and ments made in tea planting. This colony is o have 1,000,000 vines. The Consul adds entirely irrespective of whether or not the ts will succeed in awakening in the Jewish a national spirit, and forming a Judean rchy or republic, with its Parliament in lem and its representation in foreign capitals, resent agitation makes for the development of a ry which is but a shadow of its former self, and will generously respond to modern influences. Sultan seems quite disposed to grant railway, ur, and other franchises, and it is possible that ew Jewish Colonial Bank, the organisation of was decided upon in Basle, will be permitted certain guarantees to play an important part industrial advancement and growth of Palestine. movement is furthermore bringing out new ies in the Jews residing in Palestine. The ul is of opinion that the prospects are brighter than ever for the Jews in Palestine and for tine itself. European influence has obtained a old in the country, and the tide of modern ideas ot be long resisted.

CALABRIAN BERGAMOT.

It will be interesting to English perfumers to note that great efforts are being made to secure the purity of the essence of bergamot, which is largely exported from Calabria, and forms the basis of many principal perfumes. According to Consul Neville-Rolfe, the crucial test is the proportion of a substance called *Acetato di liniale*, which is the ingredient which gives the odour to the essence. The essence has been frequently adulterated with lemon juice, thereby, of course, diminishing the proportion of the essential ingredient in the fluid put upon the market. The Chamber of Commerce of Reggio delegated the examination of samples to the Agricultural School of Palermo, and asked for information on the two points—first, whether they could suggest a method for discovering adulteration; and secondly, whether the perfume of the essence of bergamot arose exclusively from the liniale contained in it. The replies obtained were unsatisfactory, as the tests proposed, such as the polarisation of light, are not sufficiently practical for the use of ordinary people, and are only suitable for a scientific man in a specially-fitted laboratory. In August, 1897, a law was passed by the Italian Parliament against the adulteration of essenees, but as it includes shumac and other substances, it will be inoperative as to bergamot, on account of the present insufficiency of chemical methods to detect adulteration, and thus to set the law in motion. The export of bergamot from the province in 1896 was 180,835 kilogrammes (398,000 pounds avoirdupois) at about 6s. 1d. per pound. Now, this is a low price, the price in 1891 having been 11s. 7d.; and, taking the average price of the last 10 years, it appears to have reached 8s. Essence of lemon brings 4s. 9d. and essence of orange about the same. It will be seen from this that until the adulteration of bergamot with lemon juice can be detected, there is great temptation to increase the quantity of the more expensive essence by the addition of the cheaper one. It is strange, says the Consul, that the attention of the perfumery trade should never have been directed to South Italy. The flowers of the orange and lemon trees, so carefully collected in the South of France, are allowed in South Italy to rot upon the ground, and might be had in any quantity for the asking. Roses and many other scented flowers grow there in wonderful profusion. Bergamot, which is the active ingredient of many scents, is to be had in plenty, and it looks as if there were a good opening for perfumery works. The soapmakers alone would be large customers.

Obituary.

SIR DOUGLAS GALTON, K.C.B., D.C.L., F.R.S. —Members of the Society of Arts will have received with deep regret the news of the death of Sir Douglas Galton, which took place on Friday, the 10th inst.,

at his house, No. 12, Chester-street. The fatal illness commenced on the evening of February 13, when Sir Douglas was seized with a sharp pain in the right ear, which afterwards affected the arm and hand, and caused the most acute suffering. It was evident to his medical advisers that Sir Douglas' illness was due to a serious attack of blood-poisoning. For many days, however, genuine hope of his recovery was entertained, as he was enabled to take sufficient nourishment to arrest the effects of the poison. But, despite the devoted nursing which was given to him and the sustenance received, other symptoms set in, and Sir Douglas endured acute agony from phlebitis of the legs. For the last ten days of his illness, the greatest anxiety was felt by Lady Galton and all the members of her family, as they feared he would scarcely be able to survive so much suffering. Yet they did not abandon all hope until Wednesday, March 8, when it was apparent to all that the beginning of the end had set in; and on Friday, March 10, Sir Douglas Galton passed peacefully away. In him the Society of Arts loses one of its oldest, most valued, and most energetic members. He joined the Society in 1856, very soon began to take an active interest in its work, and continued in intimate association with it until a few weeks before his death. In 1870 he became a member of the Council, and from that year up to the present he has been almost continuously upon it, indeed he acted either as a member of Council or a Vice-President in every year from 1870 to the present, except in 1877 and 1882. He held office as Chairman of Council in 1886 and 1887.

Born in 1822, he went from Rugby to the Royal Military Academy at the age of 15; and when he obtained his commission in the Royal Engineers he passed the highest examination on record, taking the first prize in every subject. Although a soldier, his career was almost entirely a civil one, indeed he never attained a higher rank in the army than that of captain. In 1847, he acted as Secretary to the Commission that investigated the application of iron to railway structures, and soon afterwards became an Inspector of Railways and Secretary of the Railway Department of the Board of Trade. This position he resigned in 1860, but his knowledge of railway matters led to his still carrying out a good deal of important work in connection with railways. Perhaps the most important of these was the series of experiments for testing automatic brakes, carried out in 1878 and 1879. In 1860 he was appointed Assistant-Inspector-General of Fortifications, and two years later he became Under-Secretary of State for War. After his retirement from this post he became Director of Works and Public Buildings in Her Majesty's Office of Works, an appointment which he held until 1875.

To the general public he was best known as an eminent sanitarian. For the greater part of his life he devoted himself to the investigation of sanitary questions, and of late years these attracted his attention almost to the exclusion of other matter[s]. [He] was one of the referees when the Metro[politan] Drainage Scheme was under consideration in [185]. and after the Crimean War he took part i[n the pre]paration of a report on military sanitation. [It may] certainly be said with truth that in recent ye[ars no] movement of any importance for the improvem[ent of] public hygiene occurred in which Sir Dougl[as did] not take an active share. He was a leading m[ember] of the various sanitary institutions: he took [a pro]minent part in the Health Exhibition of 188[4]; [he] was a prime mover in the International Congr[ess of] Hygiene held in London in 1891; and was [always] ready to devote his time and trouble to any [project] which seemed to hold out a prospect of ben[efit to] public health. Sir Douglas Galton took the d[eepest] interest in methods to promote the care and s[uitable] education of defective brain power, and it i[s due] to this that he assisted in founding the Chil[dhood] Society, of which he was elected Chairman, [Lord] Egerton of Tatton, being President. Dr. F[rancis] Warner and Dr. G. E. Shuttleworth were a[mong] the members of the Council. He was long [and] closely associated with the British Associ[ation], acting as one of its general secretaries for t[wenty]-five years, and it was only in 1895 th[at he] gave up that office to become President [of the] Association. He was elected a Fellow o[f the] Royal Society in 1863, and an honorary mem[ber of] the Institution of Civil Engineers in 1850. He [was] D.C.L. of Oxford, and an LL.D. of several [other] universities. He was made a C.B. in 1865, [and] K.C.B. in 1887.

As above-stated, and as, indeed, is well kno[wn to] most of the members, his association with the S[ociety] of Arts was of the closest and most intimate char[acter]. Besides taking a very large share in the g[eneral] management of the institution, as a regular atte[ndant] at the meetings of Council, he contributed larg[ely to] its proceedings. His first paper, read in 1868, w[as on] "Ventilating Stoves for Military Buildings;" hi[s last] in 1890, on the "Sliding Railway." Between [these] two dates he read papers on "Economy of F[uel]," "Sanitary Progress in India," "Tramways," "[Sanitary] Heating," "Economy in Sanitation," "Metrop[olitan] Sewage," "Mechanical Motors," and "The Sa[nitary] Functions of County Councils." He also, as Cha[irman] of the Council, delivered the opening address [of the] Sessions of 1886-7 and 1887-8. He took part i[n the] proceedings of the Conferences on Public H[ealth], Domestic Economy, Water Supply, and Canals, [and] on very many occasions presided over the So[ciety's] meetings.

LORD HERSCHELL, G.C.B.—The Society of [Arts] has lost a distinguished member by the sudden [death] of Lord Herschell at Washington on March 1st. [Lord] Herschell took part in the discussions of the Sc[ciety], and presided at the meeting of the Indian Secti[on on] January 28th, 1897, when Sir William Lee-W[arner] read his paper on the "Moral Advance of the E[mpire]

during the Reign of Queen Victoria." At eting he specially referred in his remarks in ussion to the administration of justice in India. Herschell was born 2nd November, 1837. He licitor-General (as Sir Farrer Herschell) from 1885, and he twice held the office of Lord lor. He was Chairman of the Governors of erial Institute, Chancellor of the University of , and Captain of Deal Castle. The particulars Herschell's distinguished career have been related in the newspapers, that it is not ry to repeat them here.

REW D. CHADWICK, F.C.A.—Mr. Andrew ck, auditor of the Society, died suddenly at e on 28th February last. Mr. Chadwick was eral years associated with his father, the late hn Oldfield Chadwick, in the auditing of the 's accounts, and on his father's death, in ber, 1897, he succeeded him in the office of r. He had been a life member of the Society 890.

General Notes.

LADELPHIA COMMERCIAL EXHIBITION.—Department of Science and Art has received, h the Foreign Office, a communication from irector of the Commercial Museum, Philadelphia, calling attention to a Universal Commercial ess and Exposition to be held there, under its es, during the autumn of the present year. is being erected for the purpose of the tion a series of buildings, in which will be dis- such American manufactures as are most re-tative, and best adapted to foreign require- but it is intended also to accept as exhibits articles from European manufacturers, in to afford an opportunity for a thorough omparative study of the world's industries. ongress will be presided over by the President United States at the opening Session on er 10th, and all nations will have an oppor- of being represented, and having a voice and n its deliberations, through duly accredited tes sent by the various Governments and com- l organisations.

SSELDORF INDUSTRIAL EXHIBITION, 1902.—nation has been received at the Foreign Office ere will be held at Düsseldorf, in 1902, a large ition which is now being organised by the th-West Group of German Iron and Steel In-alists," and by the "Society of German Iron-rs." It will represent all the vast industrial sts of Rhenish-Westphalia. A provisional ittee has been appointed, and it is now making e necessary arrangements for constructing suit-uildings. The town of Düsseldorf has granted a sum of £200,000 for a site. It is said that, as this Exhibition is now secured, the principal industries of Rhenish-Westphalia will probably not take part in the Paris Exhibition of 1900, as they consider that their interests will be better served by such a large local exhibition than by a small section at Paris.

ST. PETERSBURG HORTICULTURAL EXHIBITION.—Notice of this proposed Exhibition to be held in May next was given in the *Journal* for September 23 last (xlvi. 856). The following regulations respecting the Exhibition have been received from the Foreign-office through the Science and Art Department:—1. The carriage of plants and other objects from the Russian frontier to St. Petersburg will be effected without any reduction in the usual tariff, but these goods will be exempted from Customs dues if returned from Russia, *viâ* the same frontier station as that by which they entered. 2. The carriage of the aforesaid objects from St. Petersburg to the frontier station of entry will be free of charge. 3. In order to avoid any misunderstanding at the Russian frontier, all goods intended for exhibition must be marked "transit exposition," and also bear labels, which will be supplied to any exhibitor, upon application, in numbers corresponding to the number of packages. 4. Packages will be examined by the Customs in the Exhibition buildings. 5. All plants will be provided with a phylloxera certificate. The Russian Railways Administration likewise propose to adapt several of the carriages specially for the transport of plants, by fitting them with water-pipes for watering and heating.

EXHIBITION OF ELECTRICAL APPLIANCES IN BRUSSELS.—At a meeting of the Belgian Society of Electricians, recently held in Brussels, it was decided to open an Exhibition of all sorts of electrical appliances applicable to domestic uses. The Exhibition is to be held in May next, in the new Post and Telegraph Office, Place de la Monnaie, Brussels. It is the intention of the society, according to Consul Roosevelt, to make a complete exhibition of the various uses to which electricity may be applied in the household. Besides appliances for illuminating purposes, there will also be exhibited small motors for operating dumb waiters, cleaning and polishing shoes, heating kitchens, cooking-stoves, bath-rooms, and bath-tubs, electric teapots, sad-irons, domestic telephones—in fact, all appliances operated by electricity—with a view to the total suppression of the use of coal for domestic purposes.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 22.—"Electric Traction." By PHILIP DAWSON. Sir FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

Papers for meetings after Easter :—

"Coal Supplies." By T. Forster Brown.

"Electric Traction." By Philip Dawson.

"Telephones." By John Gavey.

"Wireless Telegraphy." By W. H. Preece, C.B., F.R.S.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

April 27.—"Judicial Reform in Egypt." By Sir John Scott, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive. The Lord Chief Justice of England, G.C.M.G., will preside.

It has been found necessary to change the date of this meeting from April 13 (as formerly announced) to April 27.

May 11.—"The Revenue System and Administration of Rajputana." By Michael Francis O'Dwyer, I.C.S., Settlement Commissioner, Alwar and Bhurtpore.

June 1.—"The Port of Calcutta." By Sir Charles Cecil Stevens, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

Foreign and Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

March 21.—"The Commercial Development of Germany." By C. Rozenraad, F.S.S., and Fellow of the Institute of Bankers. J. M. Maclean, M.P., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Prof. Henry R. Procter, "Leather Manufacture." Four Lectures.

April 10, 17, 24, May 1.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 20...Sanitary Institute, 74a, Margaret-street, W., 8 p.m. Dr. Louis Parkes, "Water Supply and Pollution."

Imperial Institute, South Kensington, 8½ p.m. Mr. G. Wilson Hall, "Life in Austraiia."

Surveyors, Savoy-street, W.C., 8 p.m. Col. G. W. Raikes, "The Report (No. 2) of the Royal Commission on Local Taxation, especially dealing with Valuation and Rating in respect of Tithe Rent-Charge."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. John Bilson, "Norman Vaulting in England."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. J. Duns, "Marks of Mind in Nature."

Tuesday, March 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Foreign and Colonial Section.) Mr. C. Rozenraad, "The Commercial Development of Germany."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. Ray Lankester, "The Morphology of the Mollusca." (Lecture X.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on following papers: 1. Mr. J. T. Milton, "Water-tube Boilers for Marine Engines." 2. Sir John Durston and Mr. H. J[...] "Recent Trial of the Machinery of War[...] 3. Robert Abbott Hadfield, "Alloys of I[...] Nickel."

Statistical, in the Theatre of the United [...] Institution, Whitehall, S.W., 5 p.m. [...] Udny Yule, "Causes of Changes in Paupe[...] England, chiefly during the last two Inte[...] Decades."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square W., [...] (Photo-mechanical Meeting.) Mr. W. G[...] "Automatic Adjustment of the Half-Tone S[...]

Zoological, 3, Hanover-square, W., 8½ p.m. [...] W. P. Pycraft, "Contributions to the Osteo[...] Birds" (Part III.—Tubinares). 2. Mr. G. [...]ardson Brady, "The Marine Copepoda o[...] Zealand." 3. Mr. F. E. Blaauw, "The Br[...] of the Weka Rail and the Snow-Goose i[...]tivity."

Wednesday, March 22...SOCIETY OF ARTS, John-[...] Adelphi, W.C., 8 p.m. Mr. Philip D[...] "Electric Traction."

Naval Architects (at the House of the Soci[...] Arts), 12 noon. Annual Meeting. 1. Addr[...] the Chairman, the Earl of Hopetoun. 2. Si[...] Durston, "Trials and Experiments ma[...] H.M.S. *Argonaut*." 3. Captain A. Rasm[...] "Some Steam Trials of Danish Ships."

Geological, Burlington-house, W., 8 p.m.

Japan Society, 20, Hanover-square, W., 8[...] Mr. W. Harding Smith, "Cha-No-Yiu."

Thursday, March 23...Naval Architects (at the Hou[...] the Society of Arts). Annual Meeting. 1[...] —1. Commodore G. Melville, "The local Ar[...]ment of Motive Power of Warships." 2. [...] Bruhn, "The Stresses at the Discontinuitie[...] Ship's Structure." 3. Mr. C. F. Munday, [...] Advantages of using Tchebyscheff's Ru[...] Association with the Integrator to obtain [...] Curves of Stability." 7 p.m.—1. Mr. Char[...] Haswell, "Reminiscences of early Marine E[...] Construction and Steam Navigation in the U[...] States of America from 1807 to 1850" (conti[...] 2. Mr. J. T. Milton, "Steam Pipes."

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 [...] Mr. W. Poel, "English Playhouses in the Sixt[...] Seventeenth, and Eighteenth Centuries." (L[...] III.)

Electrical Engineers, 25, Great George-street, [...] 8 p.m. Mrs. Ayrton, "The Hissing of the El[...] Arc."

Friday, March 24...Naval Architects (at the House o[...] Society of Arts). Annual Meeting. 12 n[...] 1. Mr. W. I. Babcock, "Portable Pneu[...] Riveters for Shipbuilding." 2. Mr. C. E. [...]meyer, "Practical Experience on the Stren[...] Boilers." 7 p.m.—Prof. W. E. Dalby, [...] Balancing of Engines, with Special Refere[...] Marine Work."

Royal Institution, Albemarle-street, W., 8 [...] Weekly Meeting. 9 p.m. Lord Ray[...] "Transparency and Opacity."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burli[...] house, 5 p.m. 1. Dr. Barton and Prof. M[...] "The Criterion for the Oscillatory Discharg[...] Condenser." 2. Mr. A. P. Trotter, "The [...] Variations of the Clark Cell."

Saturday, March 25...Royal Institution, Alber[...] street, W., 3 p.m. Lord Rayleigh, [...] Mechanical Properties of Bodies." (Lecture [...]

Botanic, Inner Circle, Regent's-park, N.W., 3[...]

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communications for the Society should be addressed to he Secretary, John-street, Adelphi, London, W.C.

Notices.

REIGN & COLONIAL SECTION.

uesday afternoon, March 21, 1897; J. M. CLEAN, M.P., in the chair. The paper l was "The Commercial Development of many," by C. Rozenraad.

he paper and report of discussion will be ited in the number of the *Journal* for il 7th.

Proceedings of the Society.

FIFTEENTH ORDINARY MEETING.

Vednesday, March 22, 1899; Professor ARLES A. CARUS-WILSON, M.A., in the ir.

he following candidates were proposed for tion as members of the Society:—

mann, Charles Theodore, Moorside, Ealing, W.
ke, Cyril L. C., St. Neots, Eversley, Winchfield.
llips, Lionel, 33, Grosvenor-square, W.
er, John Edwin, LL.B., 16, Middleton-road, New Vandsworth, S.W.
ak, Joseph Henry, 28, Grosvenor-road, Highbury New-park, N.
d, Arthur H., P.O. Box 120, Cape Town, South Africa.
ittow, Thomas, 35, Oxford-gardens, W.

he following candidates were balloted for l duly elected members of the Society:—

g, Ernest William, Higher Dunscar, near Bolton.
rimer, Maurice, The Spinney, Coundon, near Coventry.
nuel, Alderman Sir Marcus, 20, Portland-place, V.

he paper read was—

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.

By Philip Dawson.

There is no longer room for doubt that electricity is the one pre-eminently successful motive power for tramways. This is proved by the rapid growth of electric traction. The words "experimental line" have fallen out of use, yet it is only a few years ago that those who ventured to foretell that the trolley system would be generally introduced into this country were ridiculed. There is no country in which electric traction is advancing more rapidly, and in which finer plants are being installed than in Great Britain. The day is not far off when horses and steam will have disappeared from the streets as far as tramways are concerned, and when the horse 'bus as a competitor will be no longer known.

The problem of greatest importance, however, in which electric traction will be a principal factor, is the rapid transportation of large crowds from and to their business in our cities. The object of this paper is to investigate in a general way the special requirements of this service, and to demonstrate the special adaptability of electric traction to it.

It is evident that the only solution of rapid transit lies in railways which must be either overhead or underground, and of both London possesses a greater mileage than any other town in the world. The factor of initial expenditure must restrict the number of tracks available for the up and down traffic.

The stopping places on such lines must of necessity not be far apart, and to diminish the crowds on the platforms and to increase the number of passengers the trains must follow each other with the greatest possible frequency. Consequently the average speed of the trains must be increased as much as possible without unduly diminishing the distance between two consecutive trains, which would be dangerous.

Steam locomotives have probably reached their approximate maximum development, and the results so far obtained with them for the class of traffic in question are far from satisfactory. They do not get up speed rapidly owing chiefly to the torque on the driving axles constantly varying in consequence of the reciprocating motion of the pistons. They are not economical as their fuel consumption is practically the same whether they are exerting

their fullest power, coasting or standing still, and their maintenance is very costly.

There is a commercial limit as far as distance is concerned beyond which transmitting power electrically will not pay. But that limit varies with each case, and cannot be ascertained except by the most careful calculation after all the conditions that obtain have been minutely examined. England was the first country to introduce electric traction on railways, both underground and overhead, as instanced by the City and South London, and Liverpool overhead electric railways. But, to prove commercially that very much heavier traffic could be handled, that much greater distances could be traversed, and to develop on a large scale the necessary machinery was again left to America, and hence the necessity of being practically confined to American experience and examples in this paper.

There are practically three methods of handling electrically the traffic on a railway, namely:—

1. By locomotives or motor cars hauling a train of trailer cars.
2. By independent motor cars.
3. By a set of independent motor cars formed into a train and handled from the front car or from a so-called controller car. Each car, however, can be separated from the train, and it then becomes an independent motor car.

As regards the supply of the necessary current for the motors, there are three distinct methods:—

Firstly. By accumulators or storage batteries which may be carried either on the motor car or locomotive, or on a tender.

Secondly. By having a car containing a stationary engine, dynamo, and boiler, which supplies the necessary current to the motors on the cars comprising the train of which it is part, and as proposed by W. Heilmann.

Thirdly. By continuous or multiphase current supplied directly from a generating station or from a sub-station which, in its turn, gets its supply of energy from the main station, the current being distributed either in the form of direct or polyphase to conductors running along the lines, and from which the power is supplied, through sliding contacts on the cars to the motors.

The two former methods, as far as this paper is concerned, will not be discussed, as sufficient data are not available to justify their being considered.

The system of transmission of energy to the motors by means of conductors laid alon[g the] track, will therefore alone be considered.

This method allows of several variatio[ns as] far as the generation and distribution of [power] is concerned, amongst which the chief m[ay be] set down as follows:—

(*a*) One continuous current generating st[ation] supplying current direct to contact rail. [When] drop in pressure owing to distance bec[omes] excessive, a negative "booster" may be u[sed;] it serves, so to speak, to pump back the c[urrent] to the station, and is self-regulating, not t[aking] at any period more power than is ac[tually] required to pump the current back. S[hould] there be one or two lines too long to e[nable] them to be worked this way, polyphase [high] tension generators should supply the po[wer to] one or more sub-stations along the line, as [may] be found necessary, in which rotary conv[erters] are located, which transform the current [into] into continuous. The polyphase generat[ors] be driven by continuous current motors i[n the] generating station. As an example of s[uch] station, the new Dublin tramway power [house] may be taken.

(*b*) One central station generating contin[uous] current with sub-stations in which accumul[ators] are located along the road, and which [are] charged by means of a booster and sp[ecial] cables. As an example of this system, the [Leeds] tramways may be taken as designed by [and] carried out by, the late lamented Dr. [John] Hopkinson.

(*c*) A series of stations, as described [under] (*a*) and (*b*), situated at various distances [and] connected together one with the other. [As an] example of this, the tramways and light [rail]ways in and round Boston, Mass, ma[y be] taken, owned by the Boston Elevated Ra[ilway] Company, which has absorbed the well-k[nown] West End Company.

Data of Boston Elevated Railway.

Track miles operated	[illegible]
Number of cars	[illegible]
Car miles run during 1898	29,78[illegible]
Passengers carried during 1898......	172,76[illegible]
Number of power stations..........	[illegible]
Total capacity of power stations in kilowatts	[illegible]
Total rated indicated horse-power of engines	[illegible]

(*d*) A power station generating poly[phase] currents, which, by means of static st[ep-up] transformers, are transmitted at tensions [which] run from 2,500 to 40,000 volts to sub-st[ations] where static step-down transformers r[educe] them to pressures of 300 to 350 volts

ent at this pressure enters rotary transformers, which deliver direct current at 500 to volts to the line. As an example of this r system, the Central London Railway, ch is now under construction, may be ntioned.

) A three-wire system with continuous ent, the rails or return forming the neutral . This has been tried and found wanting, the engineers of the Central London Rail- most carefully investigated its possi-y and decided in favour of polyphase smission and rotary converters, and tly so.

rom careful calculations and the investiga- of what has been done both in Europe and erica, there is no getting behind the fact that any power station which will exceed 4,000 watts in capacity, the polyphase system is rly certain to prove commercially the only issable one. This statement is upheld by an authority as Mr. H. F. Parshall, .C.E. It is evident that in the particular s at present under consideration (suburban metropolitan communication), more than o kilowatts will be under consideration, and efore nothing, as far as the power station transmission is concerned, but polyphase ents will be considered.

here are two distinct varieties of service to atered for. One that on a system like the ropolitan and District, where the stops are uent and the runs short. The other the of long distance lines with few stops. In present paper it is only proposed to con-r the first variety. In this case the use of phase motors need not be considered, as vork entailing frequent stopping and start- they have not up to date proved satis-ory.

short examination of the importance of d acceleration on lines having stopping es at short intervals is interesting. Prac- experience with electrically-driven motor , or locomotives on the experimental track e General Electric Company, at Schenec-, has proved that it is perfectly feasible to in a speed of 30 miles an hour 10 seconds starting from a standstill. Assuming a track, and that during 65 seconds the ent is cut off, and the train allowed to t, that the brakes are then put on, the will be brought to a standstill 15 seconds , and the total time from start to stop will o seconds. Under these conditions it will und that the average speed will have been miles an hour, and that the total distance run will be about ·55 of a mile. Assuming that instead of attaining the 30 miles an hour in 10 seconds, it took 30 seconds, and that this full speed of 30 miles an hour was kept up for 40 seconds longer, and the brakes then put on, the train would be brought to a standstill in 90 seconds, and the average speed would work out as 21·66 miles an hour, or an average speed of about 10 per cent. less than in the previous case, the consumption of power, however, being much greater.

It is evident that the most important point is to attain a high average speed, and to keep the maximum speed attained as low as possible, as by so doing less power is required in braking the train, and also less power is required to run the train. The time between the moment when the maximum speed is attained, and when the brakes are put on, should be at least from 4 to 6 times that required for stopping the train, so as to allow for errors in judgment on the part of the driver, and also to enable him to make up lost time. On the Manhattan Elevated Railway, in New York, the trains which are drawn by steam locomotives take 20 seconds to attain a speed of 14 miles an hour, or less than half the speed in double the time as compared with electric traction just mentioned.

A much larger current will be required to attain a rapid acceleration than to attain a slow one, but the current will be required during a much shorter time, and the total energy supplied will be less in the case of rapid than of slow acceleration. This fact must not be lost sight of when calculating the feeders for such a system, and the train service should be arranged in such a way that as few trains as possible start together. Furthermore, the more rapid the acceleration required the larger will the motors have to be, and therefore there will be a limit, above which it will not be advantageous to push the rapidity of acceleration. In new tunnel lines, such as are now being constructed all over London, it will be evident that it is an advantage to have the stations built with a down-grade for the trains to start, so as to help the motors and reduce the current required at starting, and that similarly it will be an advantage to have an up-grade when nearing a station, so as to reduce the amount of power required in braking. By properly choosing these gradients it is found that a total economy of from 40 to 50 per cent. in the total power required by a train may be made. According to Mr. Potter's tests it was found that during acceleration an average power of

32 amperes per ton of weight of train was required.

With a complete train composed of one motor car and two passenger cars, weighing complete 148,000 lbs., a maximum horizontal effort of 9,750 lbs. was required in acceleration, the maximum current was 780 amperes at 500 volts, the maximum speed attained was 32 miles an hour, and the time taken to attain the speed was 34 seconds, the motor car being equipped with two 200 horse-power motors.

METROPOLITAN ELEVATED, CHICAGO.

Number of Cars in Train.	Average Speed (not including stops) in Miles per hour.	Average Current (not including stops) in Amperes.	Board of Trade Units Delivered at Switchload per Ton Mile.
4	14·4	148·7	·050
4	14	153·2	·053
4	14·5	151·8	·050
3	14·7	137·4	·063
3	15·1	135·6	·058
2	15·3	90·1	·058
2	16·8	106·6	·059
4	12·2	101·1	·042

Railway Co.	No. of Cars.	Weight of trains in lbs.	Tractive effort per ton.				Maximum speed in miles per hour.	Distance run.
			Maximum for given time.		Average for total time.			
			sec.	lbs.	sec.	lbs.		feet.
Metropolitan Elevated, Chicago ...	2	88,000	10	177	40	107	34·8	1,020
Lake Street Elevated, Chicago ...	2	88,000	10	135	40	84	27·6	870
Alley Elevated, Chicago	3	144,000	10	135	40	98	28·6	840
Illinois Central, Chicago	4	300,000	10	95	40	79	25·60	750
Manhattan Elevated, New York.	4	190,000	10	88	40	67	21·00	615

In another case, with a train composed of one motor car, equipped with two 125 horse-power motors and one trailer car, the total weight of train being 103,000 lbs., a maximum speed of 31 miles an hour was attained in 37 seconds, the maximum current being 500 amperes, and the maximum horizontal effort required to attain acceleration 5,640 lbs. In a series of tests made on the Nantasket Beach line it was found that with a heavy motor car, 51 feet in length overall, carrying 100 passengers, weighing 31 tons, on an average distance of 2,980 feet between stations, a maximum speed of 40 miles an hour was attained, the average speed being 18 miles per hour, and the p[illegible] required was 0·098 Board of Trade units [illegible] ton mile.

DISTANCE 2,000 FEET, TO BE RUN OVER [illegible] SECONDS, OR AT AN APPROXIMATE AVE[illegible] SPEED OF 16 MILES PER HOUR.

Time during which power applied in seconds.	Maximum speed attained in miles per hour.	Time during which brakes applied.	Avera[illegible] power-[illegible] sumption [illegible] ton, i[illegible] B.T. un[illegible]
7·5	25·75	10·0	0·03[illegible]
12·5	26·00	10·5	0·03[illegible]
16·5	26·25	11·5	0·03[illegible]
24·5	27·15	12·5	0.04[illegible]
31·0	28·25	14·0	0·04[illegible]
39·0	30·50	17·0	0·05[illegible]
53·0	36·50	22·0	0·08[illegible]

Distance to be run 2,000 feet.

Tractive effort per ton in lbs.	Maximum speed in miles per hour.	Time in seconds during which brakes applied.	Time in which 2,000 feet run.	Average speed in miles per hour.	Bo[illegible] Tr[illegible] u[illegible] pe[illegible] m[illegible]
	62·5	41·0	41·0	33	[illegible]
300	53·0	34·0	52·0	26	[illegible]
150	46·0	26·0	58·0	23	[illegible]
100	40·0	24·5	67·5	20	[illegible]
65	34·0	22·0	82·0	17	[illegible]
45	27·5	15·0	98·0	$13\frac{3}{4}$	[illegible]
35·6	23·0	12·0	127·0	$10\frac{1}{2}$	[illegible]
7·6	17·5	11·0	160·0	8	[illegible]

In an experiment with a train comp[illegible] of one motor car and one trailer car, wei[illegible] 57 tons, with an average distance bet[illegible] stations of 4,280 feet, a maximum speed [illegible] miles was attained, the average speed [illegible] 17 miles an hour, the power required being [illegible] Board of Trade units per ton mile.

From a comparison of the actual r[illegible] obtained on the elevated electric railwa[illegible] Chicago and on the Metropolitan and D[illegible] line in London, we see that whereas the [illegible] mum speed of 25 miles an hour is obtai[illegible] 10 seconds with electric traction, it tak[illegible] seconds to do it with steam locomot[illegible] and that whilst the electrically propelle[illegible] could do the distance of 1,880 feet [illegible] seconds, with steam it would take 93 se[illegible] or nearly half as much time again. If [illegible] case of electric traction the power is cut [illegible]

nent the maximum speed of 25 miles an r is obtained, and the train allowed to st before the brakes are put on, the distance sidered would be done in 76 seconds. The m driven train even then would take more 1 25 per cent. more time to do the same ance.

aving tried to show the advantages which tric traction possesses as regards the pos- lity of increasing the frequency of the ns without decreasing the factor of safety, nely, the distance between two trains, it be advantageous to see how, from an nomical stand-point of generating power, tricity is a cheaper method of operation n steam locomotion. An electrically en train only requires one man instead of to drive it, and when the train is not run- g no power is consumed and no coal or er wasted. Steam locomotives, it is well wn, use but very little less coal and water n they are standing still than when they are ning, and are much less economical, con- ning, as they do in America, from five to six nds of coal per indicated horse-power. On n line English roads it is stated that three to pounds are consumed, and taking an aver- power of 400 horse power per locomotive, a train plus engine weighing 250 tons, at a ed of 40 miles an hour, we get at the most nomical rate about 0·65 lbs. of coal per mile, or compared to the electric power ired by electric traction 13 lbs. of coal Board of Trade unit required, which is rmous—under favourable conditions it would take much over 3 lbs. of coal to give Board of Trade unit at the switchboard. properly - designed electric station with e units would probably never consume e than 2 lbs. of coal per indicated horse- er hour, or 2·65 lbs. per kilowatt hour at the chboard, and engines of the size of 4,000 ,000 horse-power would be guaranteed to sume not more than 12 lbs. of steam per indi- d horse-power hour. A large station would justify a comparatively large initial ex- se in coal handling and stoking machinery, the location of the station could be chosen s to be most advantageously situated as rds both coal and water, the coal without g handled being taken from either the 's-hold or the railway truck, conveyed matically to the coal stores, and from ce automatically to the fires, the ashes g conveyed away automatically as well. uch a station but very few men would be ired, and the cost of power could be re- duced below one halfpenny per Board of Trade unit, including expenses of every kind.

Comparing again the coal consumption per train mile on large English main line railways, which varies from 35 to 58 lbs. of coal per train mile, we get a coal consumption of from 0·146 to 2·32 lbs. per ton mile, corresponding to 28·12 to 46·4 lbs. per Board of Trade unit, required to be generated at the power-house. The following results actually obtained with slow-speed Corliss type engines and standard American railway generators, may be of interest:—

Total coal consumed, Brooklyn City Railway Company, per Board of Trade unit, 3 lbs.

Total cost, everything included, of Board of Trade unit at switchboard, 00·5,195 cents (about one farthing).

Cost of coal per unit, 0·2307 cents, about 0·166 of a penny; Union Traction Company, Philadelphia.

Poorest coal, 3½ lbs. consumed, per Board of Trade unit at switchboard.

In another case cost of coal, 0·272 cents per Board of Trade unit at switchboard, about 0·186 pence.

Total cost of unit, all included, 0·591 cents, about 0·296 pence.

Coal consumption in another case with Corliss engine, average for one year, per indicated horse-power hour, 1·65 to 1·76 lbs.

What good slow-speed Corliss engines, properly designed for railway work, compared to other engines' mean are shown by the fact that by such a change in a large American station the coal consumption was reduced from an average of 8·3 to 4·9 lbs. of coal per car mile.

From a series of figures obtained from the various Chicago electric over-head lines, from 0·16 to 0·135 Board of Trade units are required at the switchboard to drive the trains, the average speed of the trains being 13½ miles an hour, and the maximum speed obtained varying from 28 to 35 miles an hour.

The coal and water consumption, per Board of Trade unit, must necessarily be very low, the losses in the step-up and step-down transformers and in the transmission and rotary converters would not be very great, and it would be perfectly feasible to attain an efficiency of 60 per cent. at the motor terminals and of 50 per cent. on the power applied to the car axles. Large engines and large generators and converters are designed so as to take an overload of 25 per cent. for any period of time, and be capable of overloading 50 per cent. for a short time without injury, and by a selection

American Rating.			H.P. Imputed.	Amperes (Full Load).		Full Load.	Commercial Efficienc[y]		
Poles.	kw.	Speed. Revs. per Minute.		500 Volts.	600 Volts.		75 % Load.	50 % Load.	25 L[oad.]
6	165	200	237	300	275	93½	93¼	92½	[illegible]
6	225	200	321	410	375	94	93¾	93	[illegible]
6	225	150	321	410	375	94	93¾	93	[illegible]
6	225	120	321	410	375	94	93¾	93	[illegible]
6	325	100	464	590	542	94	93¾	93	[illegible]
6	325	150	464	590	542	94	93¾	93	[illegible]
6	425	150	607	773	710	94	93¾	93	[illegible]
8	425	120	607	773	710	94	93¾	93	[illegible]
8	425	100	607	773	710	94	93¾	93	[illegible]
8	425	80	607	773	710	94	93¾	93	[illegible]
8	525	125	750	956	877	94	93¾	93	[illegible]
10	525	100	750	956	877	94	93¾	93	[illegible]
10	525	90	750	956	877	94	93¾	93	[illegible]
10	525	75	750	956	877	94	93¾	93	[illegible]
12	850	120	1,206	1,545	1,420	94½	94¼	93¾	[illegible]
12	850	100	1,206	1,545	1,420	94½	94¼	93¾	[illegible]
12	850	80	1,206	1,545	1,420	94½	94¼	93¾	[illegible]
12	1,050	80	1,482	1,910	1,755	95	94¾	94	[illegible]
12	1,200	80	1,698	2,180	2,000	95	94¾	94	[illegible]
16	1,600	75	2,260	2,910	2,670	95	94¾	94	[illegible]

of proper units a very large economy could be attained.

Metropolitan Elevated, Chicago.

Length of street .... 36¼ miles.
Average distance between stations .. 1,600 feet.
Time interval between consecutive trains .... 2½ minutes.
Average speed in miles per hour .. 13 miles.
Maximum speed .... 28 miles.
Total rated power of generating station .... 5,000 kilowatts.

South Side Elevated, Chicago.

Length of street .... 18½ miles.
Average distance between stations .. 1,720 feet.
Time interval between consecutive trains .... 1½ minutes.
Average speed in miles per hour .. 14 miles.
Maximum speed in miles per hour .. 26 miles.
Total rated power (4 units 800 kilowatts each) of generating station .... 3,200 kilowatts.

Lake-street Elevated, Chicago.

Length of line .... 15 miles.
Power of station .... 3,000 kilowatts.

North-Western Elevated, Chicago.

Length of Line .... 15 miles.
Rated power of station.. { 3–1,500 kilowatts. 1–800 kilowatts. } 5,300 kilowatts.

Loop, Chicago.

Length .... 4 [illegible]
Rated capacity of station .. { 4 units 1,500 kilowatts. } 6,000 kilo[illegible]
Number of trains passing over line in 24 hours.................... 3,000 t[illegible]
Total rated power of Chicago elevated lines, approximately .... 22,500 kilo[illegible]

Nantasket Beach.

Length of line .... 20 [illegible]
Rated power of station .... 1,800 kilo[illegible]
Average distance between stations .. 4,28[illegible]
Maximum speed per hour .... 43 [illegible]
Average speed .... 25 [illegible]
Board of Trade units per ton mile, at switchboard .... [illegible]
Weight of two-car train .... 55 [illegible]

The elevated railroads of New York [a]n[d] Brooklyn have been losing business durin[g th]e last few years so rapidly that the financial [co]ndition of the Brooklyn system is serious [a]n[d] the return on investment of the New [Yo]r[k] system much reduced, and is still decli[ni]ng. The elevated railroads of Chicago have [al]w[ays] been able to earn a satisfactory dividend. [T]h[e] general introduction of electricity in th[e] Chicago system has greatly improved th[e]

proximate Weight Armature and nmutator.	Approximate Weight of Generator Complete.	Diameter of Shaft in inches.	English Rating at 500 Volts Constant Potential.			
			Classification.	Amperes. Full Load.	Approx. H.P. to Drive.	Approx. Weight of Steam-engine in lbs.
6,000	13,100	9	150 – 200	300	212	42,500
7,000	21,000	9 – $10\frac{1}{2}$	200 – 180	400	285	50,000
13,900	34,300	9 – $11\frac{1}{2}$	200 – 135	400	285	55,000
14,520	37,000	9 – $11\frac{1}{2}$	200 – 110	400	285	85,000
17,000	45,500	9 – $11\frac{1}{2}$	300 – 135	600	428	144,000
21,000	61,000	$11\frac{1}{2}$ – 14	300 – 90	600	428	85,000
25,500	60,000	14 – 16	385 – 135	770	550	94,000
29,000	65,000	14 – 16	385 – 110	770	550	100,000
31,000	72,000	15 – 18	385 – 90	770	550	180,000
32,000	75,000	15 – 18	385 – 75	770	550	198,000
31,000	72,000	16 – 18	480 – 115	960	685	181,000
27,000	69,000	16 – 18	480 – 90	960	685	187,000
32,500	76,600	16 – 18	480 – 80	960	685	192,000
36,000	87,000	16 – 18	480 – 70	960	685	198,000
0,000	100,000	19 – 22	800 – 110	1,600	1,135	215,000
4,000	107,000	19 – 22	800 – 90	1,600	1,135	237,000
7,000	116,000	19 – 22	800 – 75	1,600	1,135	285,000
55,000	130,000	22 – 25	950 – 75	1,900	1,341	300,000
58,000	158,000	24 – 27	1,100 – 75	2,200	1,556	415,000
70,000	160,000	24 – 27	1,500 – 70	3,000	2,120	460,000

ago situation, in spite of the competition
e surface trolley lines, which parallel the
ted lines in most cases. The elevated
ad problem is resolved into a discussion
eeds, station frequencies, and relative
of service. Any railroad of this class
h aims to maintain a high schedule must
se a motive power in which the possibilities
pid acceleration are a maximum, and—all
conditions being equal—should choose
particular motive power which will bring
t the quickest acceleration, consistent
due economy.

ie Manhattan system is a comparatively
le one, with four main through lines,
out branches of importance, while the
klyn and Chicago systems are composed of
k lines with branches, involving more or less
plicated switching arrangements. Until
t a year ago, the three Chicago com-
es, the Lake Street, the South Side, and the
opolitan, had independent termini in the
ness heart of the city. Now, however, the
y constructed "Loop," encircling the busi-
district, is used as a terminus for all three
and for a fourth, the North Western, now
r construction, and all the elevated trains of
ity pass round this loop on each trip. The Brooklyn elevated system has lately secured a new terminus on the Manhattan Island side of the Brooklyn Bridge, and experiments are being made with a view to converting the entire Brooklyn system to electricity in the near future. The entire New York system, however, is at present operated by steam locomotives.

The little locomotives in use on the New York system weigh 47,000 lbs., of which 31,500 are on the four 42-inch driving wheels, and 15,500 are on the four 30-inch truck wheels. The total wheel base is 193 inches, of which 60 inches is rigid. The cylinders are 12 inches in diameter, and have a 16-in. stroke. The grate area is 16·5 square feet, and the total heating surface is 4,034 square feet. There are 154 flues $1\frac{1}{2}$ inches in diameter and 75 inches long.

The Standard Manhattan Car weighs 29,088 lbs., has seats for 48, and frequently carries 100 passengers. It is mounted on eight 30-inch wheels.

The total weight of a 5-car loaded Manhattan train is about 130 tons. The weight on the drivers is 12 per cent. of the total train weight, and with 25 per cent. adhesion, the maximum drawbar pull possible for the locomotive to exert is 7,875 lbs.

The electric locomotive car of the Metropolitan Elevated Railway Company, of Chicago, weighs 53,200 lbs. complete with motors, or 40,000 lbs. exclusive of motors. It is a standard American passenger car with full seating capacity, about one-half of each platform being taken up with the cab and necessary controlling apparatus. The trail cars weigh 33,000 lbs. The seating and standing capacity of both motor and trail cars is approximately 90 passengers. The average 4-car heavily-loaded train will weigh about 100 tons, of which 32·5 tons approximately are on the four wheels of the locomotive's motor truck, and 67·5 tons are in the trail cars. From 30 to 35 per cent. of the entire train weight is available for traction under these conditions, and the maximum drawbar pull possible to exert without slipping of wheels is about 16,250 lbs.

The South Side Elevated Railway Co. of Chicago is equipped with the Sprague multiple unit system, by means of which two or more cars in a train are equipped with motors and may be operated in unison by a single controller from any point in the train. The company is now operating four-car trains on each of which is a motor truck carrying two motors. The cars weigh about twenty tons each without load, and about 60 per cent. of the train weight is available for traction.

There are therefore three distinct types of elevated railway equipment, the steam locomotive using 10 to 15 per cent. of the train weight for traction under heavy traffic conditions, the electric locomotive using 30 to 35 per cent., and the multiple unit system using any amount desired up to 60 per cent. of the train weight.

The transportation expenses of the South Side Elevated Railway in Chicago for July, August, and September, 1897, when steam locomotives were employed, were 2·8 cents per car mile, while in the same months of 1898 they were 1·9 cents per car mile, or a saving of nearly 0·9 cents, or about 33 per cent.

Metropolitan District, London.

Average speed in miles per hour......	13½.
Maximum ,, ,, ...	27
Minimum time between consecutive trains	2 minutes.
Average time between consecutive trains	3½ to 4 min.
Total weight of train	161 tons.
Average carrying capacity............	450 passen.
Weight of locomotive	47 tons.
Average distance between stations	2,600 feet.
Time required in seconds to reach 25 miles an hour starting from a standstill	30 seconds.

The figures in the above table show at o the great advantage to be gained by elec traction, by means of which speed of 25 m an hour could be obtained in 10 seconds, by simple calculation it is easy to ascer that this would greatly increase the aver speed and therefore decrease the time ne sary to do the distance.

The characteristic difference between acceleration curve of a train hauled by a st locomotive and one driven electrically is whereas the acceleration where steam is as motive power increases at first, sl following a curve which is nearly tanger the horizontal or time axis, the accelera curve in the case of electric propulsion is re sented by a straight line rising very rap and forming a very small angle with a ver axis.

It may be interesting to mention a few tails regarding the two large power stat which are now being equipped in New Y and which will operate the two large t way systems of that city, namely, the M politan and the Third Avenue. The M politan Station is now under construction, will contain eleven direct connected sets of 3,500 kilowatts, room for extension b allowed, and a capacity having been seen of nearly double that amount. following gives the particulars of the Ger Electric Company's dynamos which wil used.

The machine will have a frequency o cycles per second, at 6,600 volts. It will 40 poles, and will run a speed of 75 revolu per minute. It will be of the stationary a ture type, the core being built up of lamina ·014 inch thick. Each lamination has dove-tail projections which fit in correspon slots in a heavy cast-iron spider. Space left between the laminations at inte through which currents of air are driven b rotating field and circulating by intimate tact with core and windings. The arm winding consists of form-wound coils plac slots in the core and retained by wo wedges, the edges of which fit into recess the teeth. The field frame consists of a steel ring supported upon a cast-iron sp to this are bolted laminated core of sheet the pole pieces of which project over and port the copper field windings. The winding consists of copper strip wound on with paper insulation between turns. Tl sulation is such as to stand a test of volts alternating between the winding an

The exciting E.M.F. is 125 volts. The [colle]cting rings are of copper, and carbon [brus]hes are used. The armature winding is [woun]d to 12,000 volts alternating. The tem[pera]ture rise of the machine after ten hours' [run] at full load is well under 40° C. The [effici]encies are as follows :—

	Per Cent.		Per Cent.
[Full lo]ad	90	½ load	92·5
[¾] load	95·5	¼ load	88
[⅞ loa]d	95	Inherent Regulation.	9

[T]he steam engines which drive these [dyn]amos are cross compound Allis vertical [engi]nes, 46 inches high and 86 inches low pres[sure] cylinders, and 60 inches stroke. They will [deve]lop 4,500 indicated horse power at the [mos]t economical load, and will be able to work [cont]inuously at 6,000 horse power if required, [and] for a short space of time they are to be [able] to work at 7,000 horse-power. The crank [shaf]t is of solid steel, bored and forged, with a [hole] 16 inches diameter the entire length, and [is] 37 inches in diameter where the wheel and [arma]ture are located. The diameter of the [shaf]t in the bearings is 34 inches, and the [leng]th of the bearings 60 inches. The fly [whe]el will have cast steel centres, and the rim [will] be built up of steel plates riveted together. [The] rim will weigh 225,000 lbs., and the engine [itsel]f, complete, about 600 tons, and it is [belie]ved that as good results as 12½ lbs. of [stea]m per indicated horse-power will be easily [obta]ined. There will be several sub-stations [in w]hich will be located step-down transformers [of 3]00 kilowatts each, which will lower the [volt]age from 6,600 volts to 350 volts. At this [pres]sure the current will enter rotary con[vert]ers of 900 kilowatts each, and will be [deli]vered in the shape of a continuous current [at 5]00 volts to the tramway system.

[T]his company operates some 250 miles of [trac]ks and carries approximately 250 million [pas]sengers every year.

[T]he Third Avenue Road is now engaged in [equi]pping all existing horse and cable lines [wit]h electric traction, and for this purpose has [also] given out a contract for a power station [whi]ch will eventually contain 16 3,000 kilowatt [gen]erators. The generators will be very [sim]ilar to those described above, and are being [buil]t by the Westinghouse Company, who are [the] sole contractors for the whole work. The [eng]ines will be Marine type, vertical, and are [bein]g built by the Westinghouse Machine [Com]pany. Sub-stations with rotary transferers will be used, as in the case of the Metropolitan system.

To give an idea of what may be done as regards power transmission the following few figures may be useful. The first attempts at this class of work were made during the Frankfort Exhibition of 1891, 300 horse-power being satisfactorily transmitted a distance of 106 miles with a pressure of 30,000 volts. Since that time electrical power transmission has largely increased, and the results obtained have been very satisfactory, 4,000 horse-power at the present moment are regularly transmitted a distance of 85 miles to the City of Sacramento, California, at a pressure of 30,000 volts, where they are transformed into low pressure three-phase and continuous current for lighting, power, and traction purposes. At Telluride, Utah, 1,000 horse-power are transmitted 55 miles at a pressure of 40,000 volts; 4,500 horse-power are transmitted a distance of 40 miles to Salt Lake City at a pressure of 15,000 volts; 1,400 horse-power are being transmitted 35 miles to Fresno, California, at a pressure of 11,000 volts; 2,000 horse-power are being transmitted 30 miles to West Kootenay, British Columbia, at a pressure of 20,000 volts; 10,000 horse-power are being transmitted from Niagara to Buffalo, a distance of 22 miles, at a pressure of 10,000 volts. All the plants are working and giving satisfaction, and have nothing experimental about them, and there are hundreds more such.

In the designing and carrying out of a large system, there are three points which are frequently overlooked and which may cause a disastrous failure. These are good and adequate bonding; thoroughly good insulation, both mechanically and electrically; and trucks suited for the work for which they are intended.

As regards the bonding, the bonds used should be flexible, but, at the same time, should contain no solder or brazed joint, and they should be expanded against the side of holes drilled in the web or foot of the rail, and held in place by pins. Bonds of this description, when properly applied, can be absolutely relied upon, the contact resistance of the bond with the rail not being greater than the resistance of the solid bond.

With regard to the third rail insulators, very good results are obtained by using insulating bolts screwed into base plates which are fixed to the sleepers, cast iron chairs being fixed to the head of the bolts to hold the rails.

DISCUSSION.

The CHAIRMAN said they were all much indebted to Mr. Dawson, who was well known as one of the leaders in the introduction of electric railways into this country, for giving them so much interesting information on a subject which was now of universal interest, and he hoped for a good discussion. The author's remarks on the subject of the drop in the feeders, and the different methods of overcoming this difficulty, were of great interest, and he might say that this question was of more importance to us than to American engineers, since in this country, fortunately or otherwise, we had a Board of Trade, and had not such a free hand as they had in America. One of the methods suggested was the use of the negative booster, which was practically a series generator with the fields in series with the feeder, so that the generator added just as many volts as was necessary to compensate for the drop in the feeder. Mr. Dawson had dismissed rather peremptorily the three-wire system, about which there was a good deal of difference of opinion. He understood that this system was going to be tried on the extension of the City and South London Railway, and he trusted that it would not prove a failure in this case. He hoped there were some present who would take up the cudgels on behalf of polyphase motors, as he did not himself feel disposed to acknowledge that they were out of the question for railways running over short distances, where rapid acceleration was required. In considering the question of the amount of energy required for operating trains under the circumstances dealt with in the paper, the question of the efficiency curves of the motors was really not of much importance, because the speed of the motor was continually changing, and the value of its efficiency at a certain speed did not go for very much. The real question was, what was the least amount of energy in watt-hours per ton-mile required to cover the given distance. On the Central London Railway inclines were being used outside the stations, so that the engines might have the benefit of the incline during the process of starting. Calculation showed that the value of these grades was greatest when they acted during the first few seconds, but this was practically impossible, and he was inclined to think that rather too much was made of the advantage of these inclines. He understood that a difficulty had occurred in connection with the grades on the Waterloo and City line, which was virtually a switchback railway. It seemed that the equipment was not sufficiently powerful to haul the train up the steepest grades backwards, being designed simply with a view to the trains running in one direction only. In any railway where grades were used, the equipment should be able to haul the trains in either direction in case of emergency, such as might occur when a single line had to do duty for two. Mr. Dawson thought steam locomotives were unable to compete with tric motors in rapid acceleration; he hoped were some steam engineers present who would up that question. Steam engineers did not see realise the importance of designing locomotive short runs with rapid acceleration. It might be correct that such a curve as had been shown w fair average sample of what a steam locomotive c do at present; but he thought that if steam engi set to work to improve the design, they might curve more nearly approximating to that of the ele locomotive. The process going on during the that a steam locomotive was getting up s was one about which very little was known, very few experiments had been made with a vie ascertaining what it was which prevented the acceleration which was obtained in an electro-m The figures given with regard to the South Elevated Railway, Chicago, were of importance. assumed that under the head of transportation included the cost of the motor-men and ductors, and it was interesting to hear that on railway, when steam was employed, the cost 2·8 cents per car-mile, and that when electricity substituted it fell to 1·9 cents. In that con tion, Mr. Sprague's method of multiple unit co had been referred to, and he should be gla hear more particulars about it, as it appeare effect a great reduction in the cost of operati train. He understood that the method cons in having a single motor man located at part of the train, who, by a system of swit operated a number of motors, which migh placed on every axle; so that one man coul the work of many. There was also the advan of having a motor on each axle, which greatl creased the adhesion effect. He was not behind one in his appreciation of what the Americans done in connection with electric railways, but he sorry to see so many large contracts go across water—especially that for the Central London way. The advantage to be looked for from p such as this, was that Englishmen might be so posted in what Americans were doing, that would be able to beat them on their own ground.

Mr. LEON GASTER said trains had been wo for some time in Switzerland on the three-p system. The circuit was conveyed to the t phase motor direct without rotatory converters. London Central Railway has made use of the phase current, but uses rotary converters, w according to Mr. Parshall's design, ought to with very high efficiency; but there were s facilities there, the electricity being gene by water-power, and conveyed a good dist The question of bonding was very impo as it prevented a great drop of voltage, it was a question which was the best me

1 many respects he thought that of electric g stood first. England was very much behind egard to electric traction, but he thought the eason was that they had so much money in- in steam, which had been thoroughly tested roved successful, and they did not like the until they were perfectly sure that they would good return for their money. Positive figures, s had been given in the paper, showing the effected by the introduction of electricity, have a very important effect on the public

E. KILBURN SCOTT thought they ought to have ir understanding of what was meant by a distance; was it such a distance as that n the stations on the Metropolitan or Dis- Railways? The railways which had been re- to in Switzerland were working very well in- and he considered the traffic was going to be with entirely by the three-phase current. The ys, of which photographs had been shown, ot in many cases lines in which the stations t all close together; those in California, for e, were a fair distance apart. There they l with a three-phase current, and they might ll go through with it, and put three-phase s on the cars, and do away with rotary con- s. He suggested that we should not be in too hurry to copy the American overhead system ributing, or we might find that by the time we troduced it they had discarded it in favour of nduit system, which was already being intro- in the Washington and Third Avenue lines. ld also be a pity not to give the three-phase a trial. He believed it would accelerate quite kly as a continuous current; and that, for such ces as were required in London, it would be as economical as a combination of the three- and continuous.

H. TRUEMAN WOOD said one important con- n which might be drawn from this paper by the l public was that the time had come for insist- n electric traction on the metropolitan railways. as in Chicago when the South Side Elevated ay was constructed—not six years ago. It was from Chicago to Jackson Park, and it was not until the World's Fair had been open for some It was then worked by steam; it was a new urnished with new plant. Yet the owners had it to their advantage to give up all the steam they had and work it by electricity. It was an ead line, and he did not suppose that it mattered ins to the passengers whether they were drawn eam or electricity; but that was not the case in on. Here we were taken through tunnels in an phere which nearly asphyxiated one, and the had a right to demand that if other means of traction could be substituted for steam, the alteration should be made. It might be said that the Chicago line was a small one, and, therefore, the abandonment of the plant did not so much matter, but then they might refer to the New York Elevated Railway, which had been running a great many years, and that also had found it worth while to abandon the old plant and substitute new. Such examples ought to make Englishmen ashamed of themselves. He wished Mr. Dawson had included in his illustrations one or two of the common American electric tramways which ran from the half-finished towns of the west or south into the backwoods. Before any roads were made, a line was laid down running into the country, and rapidly drew around it a number of outlying suburban houses. A year or two ago, when he was in Tampa, which at that time was being developed as a watering place, he found that there was not a road into the surround- ing country on which a human being could walk, or a horse or vehicle travel; but there were several excel- lently equipped electric tram lines on which you could go a mile or two into the country, and walk back through the woods.

Mr. TREMLETT CARTER said he should not like it to be supposed that in America the trolley system was being given up for the conduit system to any appreciable extent, or that the former system was not perfectly successful. The conduit was only adopted for special reasons, as in Washing- ton, where it was obligatory; but directly the lines got outside the district of Columbia the trolley system was used, notwithstanding the delay which was incurred in transferring the cars from one system to the other. Some of the local authorities insisted on the conduit system, but there was no failure of the trolly system.

Mr. JAMES SWINBURNE said the growth of electric traction was so rapid that it would be a kindness to engineers if Mr. Dawson would give a lecture every few months, showing how far it had gone. In England they were apt to take a sort of parochial view, and neglect what was being done in other countries, so much so that those who did know what was going on abroad were sometimes rather ashamed of their own country. We were kept back in England by a kind of conservatism, which objected to anything new, and also by too much officialism. But, after all, that kind of pigheaded- ness which kept us back at the beginning had one good result, that when we did make a start we generally did our work very well, better often than it was done in other countries; and an industry which had got past the youthful age was often carried on better in England even than in America. He did not wish to say anything against the Americans, for whom all who knew them had an immense respect, but they had rather a way of putting down a station

and making it go somehow, and then pulling it all up and putting down a better one. We could not do that in England; if we made a mistake once, it practically gagged the industry at the start, and in some respects it was better to go slowly. One of the most important questions with regard to large power distribution for electric railways, was the use of the polyphase system. The polyphase motor on a car had two drawbacks—first, that it wanted three contacts instead of two, and the second was said to be that you could not get enough torque at starting. He could not see why this should be, and had never got a satisfactory answer to the question. With a direct current, if you wanted to get a large torque, you gave it as large an armature current as you could, and as large field excitation as possible; you increased both elements. But a polyphase motor would do that equally well. He did not care which was the armature, and which was the field, you had the two elements in the polyphase. One was connected to the line, and got the alternating current, and you could increase the field, or the induction, by reducing the number of turns, and in that way you got one element. The other element had an induced current in it, and that depended simply on what resistance you put in the circuit to start with. There was no inherent reason why you should not multiply the two effects in the polyphase as much as in the direct current motor. He could never find out what the real difficulty was from that point of view. Another subject of some importance was that of electrolysis. When electric traction was first proposed in England everybody was against it, and the first objection made was to overhead wires, which obscured the blue light of heaven and obstructed the traffic, and so on. That was now got over, because when people found that this mode of traction was adopted in all the most beautiful towns of the Continent, there was no æsthetic reason why it should not be employed on the Underground Railway or along the Old Kent-road. Then a new danger was discovered in electrolysis, and that was more serious because even engineers did not know much about it. The bald assumption that it could uot take place unless you had more than $1\frac{1}{2}$ volts was nonsense, the least difference of pressure was enough to start electrolysis when you had metals which were greedy of oxygen, such as iron. The negative booster seemed to be a solution, but on a large scale it might be difficult to work. This was a matter on which they had gone ahead immensely in America, and when Mr. Dawson gave his next periodical lecture he hoped he would tell them how the gas and water pipes were getting on, if there were any left at all. Surface-contact systems did not get over this difficulty at all; they only got over the imaginary difficulty of the trolley. There were three small points mentioned which seemed to be looked upon as American, one, the feeder booster, which was proposed first by Major Cardew; another, the compounding up of dynamos, which was proposed by Dr. Hopkinson in his three-wire patent of and was used in this country by all dynamo m since 1883 or 1884. He was not sure that Ediso not invent the same thing in 1882, many o patents of Edison about that time were almo same as some of Hopkinson, Marcel Deprez, other European inventors. Putting a motor on wheel was also an old English idea, but it came into use because we did not have any m With regard to steam locomotives, the difficu acceleration might be put very easily. In an el motor you could always, by increasing the elements, get a great torque, but you could no a large initial torque in a locomotive without h the whole engine large, because you could not work the engine. You could only fill the cyl with steam, and if you had a large cylinder was full of steam to start with, the result was, you were running rapidly, you were expanding much. The question of starting torque was understood by locomotive engineers. The Di engines, for instance, were specially designe their work; they were not designed for running, and would not draw an express train. Dawson said that in the United States they giving up high speed engines, and using C which were always comparatively slow, ever American ones, which were the fastest. B should like to know what the high-speed en were which were replaced—were they up to standard of the English high-speed engines? could not see any advantage in using a Corliss e for an electric railway. It had been said tha American high-speed engines were really tests o much steam would go through a 3-inch pipe, others, again, said that definition was incorrect, they were really a small obstruction to a 3-inch

Mr. W. M. Mordey said the discussion seem turn more on the future than the present, pe because that was more interesting. With rega polyphase working, they might take comfort fro fact that, if there was any future for it, they starting in one important case in London with phase generators, so that if found possible, late to carry the alternate current direct to the moto the cars, it could be done with a comparatively alteration. The generating plant and mains not require to be altered. This question of alte current traction was being worked out in Sw land, where so many good things in altern work had been done, and they were all wat with great interest the experiments being ma Mr. Brown on the Jungfrau Railway and elsew As far as he could gather, the future of poly traction work was going to be very great. A rate, there did not seem to be anything lik difficulty about starting that was supposed; even if there were some difficulties, it mu remembered that there was an inherent eco

ernating current machinery in one im- t respect, which might compensate for some acks. For starting, whichever system was used, vanted a large current but a small E.M.F. ect current working, the starting was done conditions of great wastefulness, because large nces had to be inserted in the motor circuit. an alternating current they could put in a E.M.F., which was not wasteful. They not forget that they owed to America practi- the present electric tramway system. He en many of the tramway systems in America, Europe as far as Buda-Pest, and he must at he was astounded at the way in which the cans had developed the system, often in the f great difficulties, and when there was not sufficient knowledge to enable them to deal ately with the problems. They did the best ould at the moment, and were not afraid to l plant when they had developed anything America had been described as the labora- f the world, and it was certainly the electrical tory. While we are glad to benefit by all perience, we must not be misled into sup- that finality had been reached, or that the t American practice is necessarily best for h conditions. England, as Mr. Swinburne id, was slow to begin, and that was why as the banker of the world. They must all Mr. Dawson for having given them so much ation on what is now being done.

Dawson, in reply, said the first time the ve booster was tried in England was at Bristol. found there that when they had a fall of ial of 7 volts, by introducing the booster they reduce that fall by four, and bring it down to well within the Board of Trade limits. It was rue there might be a difficulty in using boosters rge system, and that was why he said that in s of above 4,000 kilowatts the polyphase system e financially the only possible thing; otherwise vould practically have to make the street into a r mine. The question of the three-wire system ne they had been fighting over for a long time, e did not suppose they would agree now. It be interesting to see what were the results on outh London extension; at present it had not l so satisfactory on lighter train lines as was ted, and for that reason, as well as on tical grounds, he did not think it would be satis- y. If he proved to be wrong, he should be glad nowledge it. With regard to what was to be lered a short distance, he meant such distances tween the stations on the District Railway. experiments hitherto made with three-phase s, for which they were much indebted to the , and especially to Mr. Brown, had been on unning longer distances, and there the power cally cost nothing. With regard to the multiple-control system, there was very little information yet given as regards the financial results, but it seemed to be working very satisfactorily, and had been taken up by several large American companies. It would be very useful in cases like the Metropolitan District, where there were branches or junctions, because the train could be divided, and one part go in one direction and the other in another. He should like to see the polyphase motor system tried in England, but the question was, who would run the risk. They knew that the continuous current was economical for a certain class of work, and it could be guaranteed, but they were not so sure whether a polyphase motor would do it. The question of electric welding had been raised, but it had been abandoned in favour of cast welding, chiefly on account of the great expense attending it. It required a power of about 200 kilowatts to make a weld. With reference to the conduit system, he might say that he did not intend to raise the question of tramway at all; he was dealing rather with suburban and metropolitan railways. The conduit system had been carefully examined by hard-headed men of business and skilful engineers, and they came to the conclusion that practically there were a very few streets, in a very few towns, where conduits would he justified, the chief reason being the enormous cost, which would be much greater in England probably than in America. Here, engineers were not allowed to put a town in a state of siege; in Brussels, when the conduits were being constructed, four or five miles of the finest streets were absolutely closed to carriage traffic, and almost to that of foot passengers. He welcomed Sir Henry Wood's remarks with reference to the District Railway, which he had to use daily, and knew what the atmosphere was like. If electricity were used, it would be much more comfortable, and it would not only cost less to work the line, but many more people would travel on it. The object of the paper was to bring before the public what was being done in other countries. He had been sometimes accused of trying to introduce American goods and machinery in place of English, but his desire was just the opposite. If we did not know what other people were doing, and why other people's machinery was better or was supposed to be better than our own, we should never be able to compete with them. The result of our conservatism had simply been that we had waited until Americans had come over here and found that we were practically not in a position to do the work which was wanted at a reasonable price, and they stepped in and got the business. Had we realised seven years ago what a success electric traction was going to become, we should have heard very little of American competition. The question of electrolysis was a difficult one, but so far there had not been much complaint in England. One reason why our lines were safer than the American was that ours were laid on concrete, which had a very appreciable resistance; moreover our tracks were very well bonded, and he did not

think there would be much trouble. There was only one safeguard—good bonding and heavy returns. That was why, when you got to long-distance transmissions, you must use polyphase machinery. Otherwise the amount of copper would be too great.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Dawson, which was carried unanimously.

Miscellaneous.

NUTS AS FOOD IN FRANCE.

Throughout the centre of France, from the Bay of Biscay to Switzerland, there are large plantations, almost forests, of chestnut trees. The poor people, through the autumn and winter, often make two meals daily from chestnuts. The ordinary way of cooking them is to remove the outside shell and blanch them. The blanching is done by throwing the nuts into boiling water, and with a *briquette* rubbing them around the kettle until the inside skin peels off. The *briquette* is composed of two square pieces of wood, 24 to 36 inches long, the angles of which are notched about one foot up; they are joined like shears with a rivet. After the blanching process, a wet cloth is placed in an earthen pot, which is almost filled with raw chestnuts; they are covered with a second wet cloth, and put on the fire to steam. They are eaten with salt and milk. Hot steamed chestnuts are carried round the city streets in baskets or pails; the majority of the working people, who usually have no fire early in the morning, eat them for their breakfast, with or without milk. These nuts are often used as a vegetable, and are exceedingly popular, being found on the tables of the well-to-do and wealthy. They are served not only boiled, but roasted, steamed, pureéd, and as dressings for poultry or meats. Chestnuts are made into bread by the mountain peasantry. After the nuts have been blanched they are dried and ground. From this flour a sweet, heavy flat cake is made. It resembles the oaten cakes so popular among Scotch peasants. The United States commercial agent at Limoges says that when these nuts are stored they are very apt to heat and ferment, and great care must be taken to prevent this; they are placed in cool, airy bins, so that the air can readily pass through the pile and perfect ventilation be obtained. The walnut tree is very generally grown all over France, but more especially in the central and eastern departments. Walnuts, as an article of food, are losing ground in France because of their scarcity. The trees have been in great demand for timber and furniture-making; nevertheless there are certain sections of the country in which these nuts form a regular article of diet. The peasants eat them with bread t[illegible] oftentimes been rubbed with garlic. The h[illegible] effects are considered good, replacing mea[illegible] large extent. These nuts are also used to[illegible] oil. It is much cheaper, and similar in[illegible] to that pressed from olives, and is emplo[illegible] adulterate the latter. The prisoners in [illegible] prisons are, says the commercial agent, e[illegible] in cracking walnuts and picking out the [illegible] which are pressed into oil. Almonds are [illegible] exported from France. The climate of the [illegible] and southern departments of the country ar[illegible] favourably adapted to the growth of thi[illegible] In the summer, the almond, while the shell an[illegible] are soft, green and tender, is sold by the d[illegible] hundred in the markets, at from one farthing [illegible] pence halfpenny per dozen, according to the co[illegible] of the crop. The meat is white and creamy. [illegible] article of food they are not used as extensi[illegible] chestnuts and walnuts. Almond oil is emplo[illegible] various purposes. Apricot stones are often [illegible] with almonds to adulterate the oil. Confec[illegible] and bakers consume large quantities of these [illegible] making different kinds of cakes and swee[illegible] Hazelnut trees are only grown for their fru[illegible] although they will flourish in nearly all the [illegible] ments, the nuts are considered a luxury, a[illegible] always high-priced. Hazelnuts are eaten gree[illegible] almonds, in the summer, when they are sold a[illegible] reasonable rates. The exportation from France [illegible] important. The pea-nut, so common in the [illegible] States, is very rarely eaten roasted in Fran[illegible] nearly all that enter the ports are importe[illegible] Spain, Italy, and Africa. The variety is sm[illegible] uninviting, and very high in price. The ta[illegible] these nuts, as a food, is said to be growing. [illegible] tons of pea-nuts are imported from the West C[illegible] Africa, India, and the Malayan Archipelago, [illegible] sold in Marseilles and other centres. These are [illegible] pally bought for the oil which is extracted from [illegible] Pea-nut oil is used for cooking purposes, and [illegible] adulterant and substitute for olive oil. Many phy[illegible] in different parts of Europe have been mak[illegible] periments as to the nutritive and medicinal q[illegible] of all kinds of nuts, and have advanced views [illegible] ing their use as food, under certain conditio[illegible] special diseases. Nuts contain a special kind [illegible] especially adapted for lubricating and softeni[illegible] muscles. Some practitioners claim that [illegible] people would be benefited by a more extens[illegible] diet. The only evil to be overcome is that t[illegible] should be thoroughly masticated.

RAMIE CULTIVATION IN KORE[illegible]

The ramie stalk indicates its maturity for goo[illegible] by turning yellow, and the leaves curl inwards [illegible] end. In curing, the bark is loosened with the [illegible] nail, and is then stripped off with the aid of a b[illegible]

This is done as soon as the stock is cut. :cortication must be delayed, the stems are in water to prevent drying. This stripping is done by the women. The stripped bark is 1 the shade for several days, and is then made) more or less compact bundles for packing)ony back. The plant is propagated by trans- g the small rootlets that spring from the main This is done soon after the breaking up of Plants may be raised from seed, but the method is preferred, and almost universally :d in Korea. The cultivation consists in ; about the plant just enough to keep it free eeds; deep cultivation is not deemed neces- There are three cuttings annually, in June, t, and again in September. Great care has to rcised in making these cuttings, so as not to the young shoots that have sprung up, and hich the next crop depends. Moist, rich loam most suitable soil for its cultivation. Stable is used as a fertiliser. Warm temperature e plant. The United States Consul-General ul says that there are two kinds of the ramie grown in Korea, but he is unable to state r they are distinct families, or simply varieties same. *Moshi* is the name given to the care- ltivated one, and the fibres of this plant pro- e silky threads made up into the highly-prized loth. The other plant, called *sam*, seems of growing almost everywhere. It is found in lens as a weed, and it will grow on rough hill- id by water-courses. Neither barrenness of r drought seems to kill it, through, of course, ceptible to care and attention. It is used for the coarse fabric worn by the poorer classes mer, and for the very extensive mourning es of all classes—a veritable "sackcloth." s used for the outer gowns of both sexes. No woman of any means in Korea is without one e garments made from moshi, which ranks and is almost as pretty as, silk. The sam is, r, just as popular among the poor, and is in- ible for the three years' mourning periods that ich an important part of every Korean's life. once started, becomes a permanent crop, easy and care for, and of much value. There are ean statistics as to the production of the fibre, there are supposed to be 12,000,000 inhab- n Korea, it will be seen, from what has been the uses to which the ramie fabric is put, that duction must be considerable. There is no of either fibre or fabric. During the year 1897, trian expert in ramie visited Korea, with a process for the rapid handling of decorticated hich he claimed to be able to turn into the d silk-like article in two hours. The Koreans ich interested in his proposition to establish a y in Korea, but declined to pay the large cash required for the use of the secret process. It that the culture of ramie could be increased a indefinitely.

Notes on Books.

LANDMARKS IN ENGLISH INDUSTRIAL HISTORY. By George Townsend Warner. London: Blackie and Son, Limited. 1899.

It is an excellent sign of the tendency of modern education in our larger public schools towards increased breadth of scope to find a Harrow master departing from the ancient lines of historical teaching and producing a book like the present. The study of English history was never very greatly honoured at Harrow. In years gone by it was made the subject of that very perfunctory duty known as the "holiday task," and the time devoted to it was generally a portion of the last day of each holiday, and the first evening after each return. Perhaps things are better now, and it is to be hoped that Mr. Warner will not be content with having produced this excellent text-book, but will induce some of his pupils to study it.

There are very few books dealing with English commercial history. Green touched on the subject, and Professor Cunningham's "Growth of English History and Commerce" is recognised as a standard work on the subject. Many books have of course dealt with the development of cammerce, if not with its history, and the history of invention, especially of special branches of invention, has been made the subject of much excellent work. But the field which Mr. Warner has taken for himself may be said to have been quite unoccupied. Nobody—so far as the writer of this note is aware—has previously attempted to sketch, in a fairly popular form, the growth of English industry and trade from the times when Cornwall was known—if it ever was so known—as the Cassiterides, down to the date of the latest labour difficulties. Intimidated perhaps by the enormous mass of detail which would be required for a complete history of English industry, the author has, as his title indicates, endeavoured to depict the chief characteristic, or, as he calls it, landmark of each age, and to show its causes and consequences.

After an introduction and a chapter on the industrial condition which prevailed before the Norman conquest, he gives, under the title of "The Manorial System," an account of land tenure and agriculture in Norman and Plantagenet times. Then comes a chapter on "Towns, and the Beginnings of Town Life," in which the rise and development of the guilds is described, and the general conditions indicated under which craftsmen worked and traders dealt. A chapter on "The Exchequer" shows how the revenue was collected, and how accounts were kept without arithmetic. The next principal landmark is the "Black Death," the effects of which in upsetting the old state of things, and introducing new developments into agriculture and commerce, are hardly realised, except by the few who have made a special study of the time. An account of the woollen industry and of the "mercantile" system leads up to

the times of Elizabeth, and the beginnings of colonial expansion. Then, after a survey of English industries, the origin of banking is described, and its growth. Then comes the growth of Greater Britain, and the trade wars of the 18th century. A single chapter on machinery and power is considered sufficient to describe the results of the introduction of the steam-engine and all the enormous changes conquent thereon. This portion of the book seems somewhat inadequate; indeed, a history of industry would not be ill-proportioned in which the first half was devoted to commerce and industry before the introduction of power, and the second to its later and greater developments. Perhaps some day Mr. Warner mey expand this 18th chapter into a volume. There is ample material; indeed, perhaps too much. The remainder of the book deals with modern developments and modern economic theory, the subject being indeed brought down until the present day, in the last chapter on "Modern Conditions: Trade and the Flag."

General Notes.

Sir Henry Doulton.—A reredos has been erected in the chapel of St. Thomas's Hospital in memory of Sir Henry Doulton, who was for many years Governor and Almoner of the hospital. The reredos is the work of George Tinworth, and was presented by Sir Henry Doulton's children. It contains three panels—the subject of the centre panel is the Ascension of Christ, that of the second the recognition of the Saviour by Mary after the Resurrection, and that of the third the evidence given to St. Thomas of the Resurrection. The reredos was consecrated on Tuesday last, the 21st inst., by the Bishop of Rochester.

MEETINGS OF THE SOCIETY.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Prof. Henry R. Procter, "Leather Manufacture." Four Lectures.

Lecture I.—April 17.

Primitive methods—Difficulties of investigation—Sources of raw material—Methods of curing—Anatomical structure of skin—Arrangement of hair-pores—Chemical character of skin and epidermis—Manufacture of gelatine—Soaking and softening of hides and skins preparatory to tanning.

Lecture II.—April 24.

Removal of hair and wool—The staling p
Bacteriological and chemical actions involved
lation by lime—Practical methods—Chem
liming process—"Buffalo" method—Pullm
direct process—Use of alkaline sulphydrates—
—Mechanical operations—Deliming pro
Chemical and physical considerations—"
down" with acids—Fermentative methods—T
drench—Bating and puering.

Lecture III.—May 1.

Physics of tanning—Theory of the pickling
—Mineral tannages—Tawing with alumina
Chrome tanning—Heinzerling process—Sch
"two-bath" process—Basic or "one-bath"
—Iron tanning.

Lecture IV.—May 8.

Oil dressing—The chemistry of the process
binations of oil and mineral tanning—V
tanning matters—Chemistry of the tannins—
methods—Combination of vegetable and
tanning—Currying—The chemistry of oils
used—Theory of the currying process.

MEETINGS FOR THE ENSUING W

Monday, March 27...Imperial Institute, South Ke
$8\frac{1}{2}$ p.m. Mr. Sidney G. P. Coryn, "Living
of Canadian Ranch and Prairie."
Cleveland Institute of Engineers, Middl
$7\frac{1}{2}$ p.m.
Geographical, University of London, Bu
gardens, W., $8\frac{1}{2}$ p.m.
Institute of Public Health, 20, Hanover-sq
$8\frac{1}{2}$ p.m. Mr. W. J. Dibdin, "Sewage Di
Actuaries, Staples-inn Hall, Holborn, 7 p.
Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.

Tuesday, March 28...Medical and Chirurgical,
over-square, $8\frac{1}{2}$ p.m.
Civil Engineers, 25, Great George-street
p.m. Mr. Robert Abbott Hadfield, "
Iron and Nickel."
Photographic, 12, Hanover-square W.
(Technical Meeting.) Mr. T. Manly, "
with Carbon Tissues, a new method of
Printing."
Anthropological, 3, Hanover-square, W.
Colonial Inst., Whitehall-rooms, Whiteh
S.W., 8 p.m. Sir William MacGregor,
New Guinea."

Wednesday, March 29...Aeronautical (at the Ho
Society of Arts), 8 p.m. Mr. Perciva
"Andrée's North Polar Expedition:
suggestions for future Polar Explor
Balloon."
British Astronomical, Sion College,
embankment, W.C., 5 p.m.
Mining and Metallurgy, Geological
Jermyn-street, S.W., $6\frac{1}{2}$ p.m. Annua
Meeting.
Chemical, Burlington-house, W., 8 p.m
Meeting. President's Address.

urnal of the Society of Arts.

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FRIDAY, MARCH 31, 1899.

communications for the Society should be addressed to he Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

INDIAN SECTION.

hursday afternoon, March 9, 1899. The RL OF ONSLOW, G.C.M.G., Under-Secre- of State for India, in the chair.

he paper read was—

LEPROSY IN INDIA.

By H. A. Acworth, C.I.E.

he statement of objects and reasons ap- ded to the Bengal Bill No. III., of 1895, ch ultimately became the Bengal Lepers No. V. of 1895, begins with the following ds:—

The expediency of segregating pauper lepers r proper safeguards, and of forbidding lepers rally from exercising certain trades and callings ected with human food, drink, and clothing, was d by the Leprosy Commission which visited a in 1890-91. Experience in Bombay having n that these recommendations can be success- carried into effect, the accompanying Bill has prepared, &c."

n 30th July, 1896, a Bill was introduced the Legislative Council of the Government India, which became in time the Lepers No. III. of 1898. The statement of cts and reasons attached to that Bill opens these words:—

The expediency of segregating pauper lepers r suitable safeguards, and of forbidding lepers rally from following certain trades and callings ected with the bodily requirements of human gs, was urged by the Leprosy Commission. . . . . year an Act was passed by the Bengal Council . . . . The present Bill has been prepared on ines of the Bengal Act."

On the introduction of the Bill in the Government of India Legislative Council, the mover, Mr. Woodburn, now Sir John Woodburn, Lieutenant-Governor of Bengal, made the following observations:—

"In 1890-91, a Leprosy Commission visited India, and a couple of years later submited a report to the Government of India, pressing on it very earnestly two questions, the segregation of lepers, and the restraint of lepers in certain callings in which they were brought into immediate contact with the food and clothing of their neighbours. The Government of Bombay had already taken action in that direction, with the help of a very munificent donation from Sir Dinshaw Petit. They constructed in 1890 a lepers' asylum in Bombay. That asylum, I believe, contains accommodation for about 300 lepers, and the result has been to free the city of Bombay from the beggars who extorted alms by the exhibition of their sores. The uufortunate creatures subjected to this dreadful malady have now been removed to a hospital, in which that comfort and attention are given to them to which their pitiable condition gives them a just claim. The Government of Bengal followed that example last year, and passed through their Local Council a Bill for the two purposes I have mentioned; the segregation of lepers, and their prohibition from certain callings."

The object of the writer in making these references is two-fold; first, to point out that the legislation undertaken in the Councils of Bengal, and of the Viceroy, was avowedly based upon recommendations made by the Leprosy Commission; secondly, that both Governments acknowledged that an example set in Bombay had encouraged and induced them to undertake that legislation. Sir John Woodburn's account of the action taken in Bombay is hardly accurate; but the error is one which has no interest except for the present writer, who will be excused, perhaps, for reverting to it further on. It will suffice to say here that the Government of Bombay never erected a leper asylum in Bombay, and that though Sir Dinshaw Petit did offer a lakh of rupees for the purpose, it was never spent.*

Now is it true that the Leprosy Commission recommended the segregation of lepers; meaning, of course, their compulsory segregation? In both Councils their authority was appealed to in justification of legislative measures for the enforcement of a system of compulsion; and the word segregation, as

* The asylum, built in 1890, was at first known as the "Acworth Asylum," and was so styled in Government resolutions. The writer requested (and wrote accordingly to Government) that the name might be changed to the "Matoonga" Asylum, after the suburb in which it was built.

used in these Councils, must clearly be understood in this and no other sense.

Among the definite conclusions at which they arrive, the Leprosy Commissioners say:—

"3.—Though, in a scientific classification of diseases, leprosy must be regarded as contagious, and also inoculable, yet the extent to which it is propagated by these means is exceedingly small."

If this be so, the writer must confess that he fails to understand on what principle save, perhaps, that of heredity segregation, or voluntary isolation, can be defended as of any value.

Going on to "Practical Suggestions," the Commissioners say that segregation "may be voluntary or compulsory, and in either instance partial or complete. Complete segregation has never yet been possible." They then consider the examples set by the Sandwich Islands, and Norway, and go on to say:

"For India, complete compulsory segregration may be considered to be absolutely impracticable. Neither do the conclusions given . . . as to the nature of the disease, justify any recommendation for absolute segregation. The presence of a leper in a healthy community is a source of danger no greater than the presence of an individual suffering from tuberculosis. Both diseases are contagious in an equal and minimal degree. The amount of ulceration which exists in both diseases is to some extent a measure of the danger of contagion.

"It is impossible for the same reasons to advise compulsory partial isolation. Voluntary isolation is, therefore, the only measure left for consideration. Among civilised communities the separation of those suffering from many diseases other than leprosy is encouraged. The voluntary isolation of the leper is, therefore, no exception to this custom. For this reason the Commissioners recommend the adoption of a voluntary isolation as extensive as local circumstances allow. Further, by permitting marriages among lepers, the plan suggested might be the more easily carried out."

The Commissioners then go on to recommend that the crowding of lepers into large towns should be discouraged, for a variety of general reasons, but not because there is any risk of their diffusing the contagion of leprosy; that municipal bye-laws should be passed, preventing "vagrants suffering from loathsome diseases from begging in or frequenting places of public resort, or using public conveyances;" also that leper asylums should be built near towns, and that the "authorities should have the power of ordering lepers infringing the regulations, either to return to their homes, or enter an asylum." They also recommend that lepers should be debarred from following occupations which concern the food, drink, clothing of the people, but guard thems[elves] by adding that they recommend this "[...] apart from the dread of a possible infectio[n]."

"In no case," say they, "would the C[om]missioners suggest an Imperial Act, espec[ially] directed against lepers as such, for these [are] far less dangerous to a community than in[...] or syphilitic people."

The writer would here observe that he [does] not presume to state any opinion of his ow[n on] the questions of the hereditary or contag[ious] character or otherwise of leprosy. Fo[r in]formation on these points, he goes to [the] leaders of medical science; though they, [un]fortunately, may speak with an uncertain v[oice]. All that the writer, and those who, like him[self], have been concerned with the questio[n of] leprosy in its administrative aspect, look [for], or are capable of discussing, is a wor[king] hypothesis. It was, he believes, Dr. H. Vandyke Carter—*clarum et venerabile no[men]*—who spoke of contagion as a "good wor[king] hypothesis." Dr. Vandyke Carter [was], nevertheless, for many years a non-[con]tagionist, though the writer is not sure whe[ther] in later life the views of that most eminent [man] were not modified or changed.

The references which have been made t[o the] report of the Leprosy Commissioners ma[ke it] abundantly clear that the legislation which [has] been undertaken in the Bengal Council, a[nd in] that of the Viceroy, would never have [had] their concurrence, and that to have quo[ted] them, and their recommendations, in sup[port] of it, seems to indicate a misapprehensio[n of] their views.

The writer must repeat that if the [con]tagiousness of leprosy may for practical [pur]poses be disregarded, if it is not a "go[od] working hypothesis," he is at a loss to [com]prehend why lepers should be singled ou[t as] the objects of any of the measures which [the] Commissioners deem to be justifiable. It se[ems] to him that the Commissioners, however [con]vinced they may have been of the accura[cy of] their opinions, had not what is comm[only] called the courage of them. They repu[diate] the risk of the disease being diffused by [con]tact, and then recommend, or suggest, or [half] suggest, a series of measures which cann[ot be] justified on any other grounds. The words "[half] suggest" are meant to indicate the reco[gni]tion of the value of isolation, coupled wit[h the] whittling away of the value of it by maki[ng it] voluntary. The Commissioners must have [been] aware, by the experience gained on the [spot]

that in India voluntary isolation is no isolation at all, and that a voluntary asylum has almost no effect whatever in relieving the streets and public places of a town from the presence of lepers. Dr. G. A. Hansen, in an article in *The Lancet*, in October, 1893, dwells on the contradictory character of this part of the report.

The Committee of the National Leprosy Fund, in commenting on their Commissioners' report, expressed their "entire dissent from the conclusion that segregation was either impracticable or undesirable." "They entertained a precisely opposite opinion," and "would be sorry if the Government of India were encouraged by the report of the Commissioners to refrain from taking the necessary steps in the direction of such segregation of lepers as may be found possible." They then expressed their concurrence in views formerly expressed by Dr. Vandyke Carter, and which favoured the erection of leper asylums, the establishment of leper colonies or villages, in all of which compulsory segregation should be enforced, together with the strict isolation of leprous subjects retained at home at the express wish of their friends.

This last provision has been enforced in Norway since 1885, when a law to that effect was passed at the instance of Dr. Hansen, the Inspector-General of Leprosy, and it illustrates the view of that authority that separate sleeping accommodation, a separate food apparatus, and strict cleanliness of house and person, are "usually isolation enough to prevent the spread of leprosy."*

It is interesting to note that the first name signed to the committee's memorandum is that of George N. Curzon, then Under-Secretary of State for India, and now Viceroy of India. Of the medical men who also signed it, two only failed to append minutes of dissent from the views of the committee as to compulsory segregation. Mr. Jonathan Hutchinson, Sir Dyce Duckworth, Sir Joseph Fayrer, Sir Andrew Clark, Sir Guyer Hunter, Sir James Paget, all dissented from those views.

Such being the array of expert knowledge and talent in favour of the Commissioners' views upon the question of compulsory segregation, is there any likelihood that, circumstances remaining as before, any legislation in that direction would have been yet undertaken in India? The writer is firmly convinced that there is not;* and that in spite of the minute of the Committee of the National Leprosy Fund, the Governments in India would not have moved if circumstances had remained as before. If, indeed, either the report of the Commissioners or the minutes on it had supplied the necessary stimulus, it may be alleged with some confidence that the Government of Bengal would not have waited for two years, or the Government of India for three years, before dealing with the question. It was the stimulus supplied and the example set in Bombay which were really the parents of legislation at Calcutta and at Simla.

The question of leprosy as an administrative problem had become urgent in the city and presidency of Bombay some considerable time before the death of Father Damien (April, 1889), or the foundation, under the chairmanship of H.R.H. the Prince of Wales, of the National Leprosy Fund (June, 1889), but it was the creation of this fund, and, in particular, the association with it, and the energetic leadership and control, of His Royal Highness, which furnished the momentum, under which a solution of the question was rendered possible. Our great English moralist says :—

> "How small of all that human hearts endure,
> That part that Kings or laws can cause or cure."

There may be some truth in this, as a general proposition, but it has no correct application to the present question, or to our Kingly Commonwealth of England. On the contrary, it may be confidently asserted that it was to the personal influence and capacity of H.R.H. the Prince of Wales, that we owe it that the question of leprosy in India was made ready and ripened for solution, instead of being allowed to linger on as an unmanageable administrative difficulty for an unknowable series of years.

By the census of 1881, the number of lepers in the Bombay Presidency was 10,095, and in the rest of British India, 108,858, or a total of 118,953. By the census of 1891—which was after the period which the writer is about to consider — there were 10,187 lepers in Bombay, and 94,510 in the rest of British India, to which, since 1881, Upper Burma, with 3,504 lepers, had been added. There was a great diminution in 1891, as compared with the

* Hansen, *Lancet*, October, 1893—"Hansen and Looft on Leprosy," 1895.

* The writer says "*yet* undertaken." He has no doubt, seeing the position he occupied on the Committee of the National Leprosy Fund, that the able and resolute man who is now Viceroy of India would not have waited long after his arrival to initiate a measure for the segregation of lepers.

figures of 1881, in Bengal and Madras, the numbers being, 76,079 for Bengal, and 11,967 for Madras in 1891, against 92,181 and 14,088 in 1881. In Bombay the numbers had remained nearly the same.

The census figures can only be taken as an approximation to the truth, for there can be little doubt that numbers of persons who were affected only with what is called white leprosy had been included as lepers, and, on the other hand, that some true lepers had escaped enumeration. In the early stages of the disease, true leprosy is often very difficult, and to a layman impossible to detect. The writer has seen many cases in which the only indication of leprosy has been a small patch of discoloration on the skin, very often covered by the clothes. He remembers one case in the Matoonga Asylum, in which the patient was a fine, robust, healthy-looking young woman of the Maratha caste, who showed no sign of the disease, excepting a small light - coloured patch, called by the doctor an anæsthetic patch, high up on the inside of the left thigh. In another case, a female child of six years' old, there was one such patch on one arm, and another on the buttock (right hip). Photographs of the latter case were included among a number which he sent to the Medical Secretary of the National Leprosy Fund. Such cases as these would never have been included among lepers by any census enumerator.

Without going into the classes into which true leprosy is divided, nodular or tuberculous (*lepra tuberculosa*), anæsthetic (*maculo-anæsthetica*), and mixed, if a separate division is now recognised under the title of mixed, the writer would point out that in Western, and he believes in other parts of India, two kinds of so-called leprosy are popularly recognised. One of these is black leprosy, and called in Marathi raktapiti, and the other white leprosy, or kor. The former is true leprosy; the latter, Vandyke Carter says, has "hardly anything in common with true leprosy." . . . "It is included among a group of skin diseases, known as 'kushta.' The leprosy of the Jews was clearly the same as the 'kushta,' of Hindu writings. . . . The expression leprous as snow can only refer to some skin disease, probably 'kor.' It cannot possibly be true leprosy. 'Kor' and 'raktapiti' are totally distinct."* "What is called 'white leprosy,'" says Mr. Jonathan Hutchinson, "is usually leucoderma, a disease which has no relation true leprosy."

White leprosy, therefore, kor, or leuc derma may be eliminated from consideratio altogether. Every measure contemplated effected in India for dealing with leprosy h had relation to black leprosy, or raktapiti.

There were several leper asylums in t Bombay Presidency in 1889. There were tv in Belgaum, one at Ratnagiri, and one Trombay, close to Bombay. This was a ve small one, accommodating about 20 patien and had been established by the charity of Parsee gentleman of the All Bless famil There was also at Byculla, in the heart of t city of Bombay, a leper dharmsala, attach to a dharmsala for indigent persons. Th were established by Sir Jamsetjee Jeejeebho an endowment provided for a small daily iss of food and money, and in 1889 this dharmsa contained from 150 to 200 lepers from all pa of the Presidency. Dr. Vandyke Carter h noted in 1876, in a report on leprosy Kattiawar, that it was customary to send b cases from that province to the leper dhar sala at Byculla.

It may be added that there was a lep ward attached to the Central Jail at Yerrowc near Poona, to which leper criminals, if long terms of imprisonment, were sent. T lepers here were isolated, and did not mix w the healthy prisoners. Compulsion, of cour is part of a prison administration, and the was no difficulty in enforcing it at Yerrowd but the fact that it was enforced showed th where it was possible to resort to it, the nece sity for compulsory isolation had already be recognised as a "good working hypothesis The case was the same in Madras, where ward for criminal lepers had been attached the leper asylum in that city.

In every part of the city of Bombay lep were, in 1889, more or less in evidence, in ev stage of the disease, and exhibiting in public streets every one of its hideous deform ties. On the occasions of Hindu festivals th crowded to the temples on the sea-shore, lini the streets in scores and hundreds. Th occupied the verandahs and courts of em houses. They washed and drank from public taps. They scattered their rags ab shops and markets, and instead of using, l Job, potsherds to scrape themselves with they used rough stones from the heaps of r metal stacked at the street sides.

For some years a sense of this evil had b growing. In 1883 the Roman Catholic Bis p

* H. Vandyke Carter, Trans. Medical and Physical Society, Bombay, 1871; No. XI., p. 74.

f Bombay had applied to the Government for he grant of one of the old forts of Sion, Matoonga, Warli, or Sewri, to turn into an sylum for lepers. His request was not comlied with, but the Government intimated that hey would gladly see an asylum established in Bandora or in Kurla, outside the limits of the ity. A year or two afterwards the tiny asylum t Trombay, already referred to, was estabshed, and also the asylum at Ratnagiri. In ebruary, 1888, the Municipal Commissioner Mr., now Sir Charles Ollivant) called on the Health Officer for a report with reference to he leper dharmsala at Byculla. Early in 888 the Inspector of the Education Departent drew the attention of the Government to e fact that a colony of lepers had established emselves in close proximity to some large chools; and, being also a member of the Bombay Municipal Corporation, he brought e matter forward in that body, desiring to now what powers the Health Officer required o deal with the evil.

The Commissioner of Police in June, 1889, eported that lepers were on the increase; that e could not deal with them, because there as no place to which they could be sent; that was useless to place them before the magisrates as vagrants, for the magistrates would ot send them to jail; that there were 430 epers in the city at the last census, and at the me of writing probably twice as many; that Section 424 of the Municipal Act was put to force he could clear the city of them in a w days, supposing there was any place to end them to; and that the necessity of clearing e city of them and isolating them was urgent. he Municipal Commissioner, in sending on is letter, said that the existing provisions of e law were totally inadequate.

In August, 1889, the Government of Bombay irected the Municipal Commissioner to remove e lepers from the place complained of by the ducational Inspector. They added that it as the duty of the Municipality, under ection 424 of the Bombay Municipal Act, to emove persons suffering from dangerous iseases to hospitals or asylums, and if there ere no suitable hospitals or asylums in existnce they should be provided.

To issue such an order as this from the ecretariat was easy enough; to carry it out as quite another matter. Supposing the stimate of the Police Commissioner as to the umber of lepers to be accurate, and that there ere 860 requiring removal, it would have cost, n the basis of the expenditure afterwards incurred at Matoonga, and which was rigidly economical, at least three lakhs of rupees to build an asylum for them, even supposing the land to have been obtained free, and a monthly expenditure of Rs. 8,600, equal at 4 per cent. to a further capital of nearly 26 lakhs, to maintain them. Moreover, the law quoted by Government gave no adequate power to any authority. Section 424 of the City of Bombay Municipal Act, III. of 1888, runs nearly as follows:—

"The Commissioner, or any Police Officer empowered by him in this behalf, may, on a certificate from the Health Officer, or any duly qualified medical practitioner, order the removal of any person suffering from a dangerous disease, and who is without proper lodging or accommodation, or who lodges in a building occupied by more than one family, to a hospital where such diseases are treated."

This is an extremely valuable provision in its way, and is constantly acted upon in cases of small-pox, cholera, and so on, but its futility in cases of leprosy consists in this, that though it gives power of *removal*, it gives none of *detention*. A person suffering from cholera or small-pox is generally glad to be removed to a hospital, and glad or not, is physically incapable of leaving it until he has recovered; then he is allowed to leave it, and no one tries to detain him. But the case of a leper was quite different. He was as well able to leave the hospital the hour after he was taken there as he was when he came in, and if he wished to do so no one could prevent him. The section was, therefore, useless as applied to lepers, and the orders of Goverment dead at their birth. The Corporation realised this, and simply "recorded" the order, without attempting to take action on it.

Before matters had reached this stage the foundation of the National Leprosy Fund, and the public action in connection with it of H.R.H. the Prince of Wales, had stirred into movement the *non possumus* of India. In June, 1889, the Supreme Government issued a Resolution on the subject of leprosy, which, together with a draft Bill for dealing with lepers, was circulated to the various provinces for opinion. The main features of this Bill were as follows:—

A leper was defined to be "a person certified by a medical practitioner, having from the local Government general or special authority, to be suffering from leprosy." The writer may observe in passing, that in his opinion this definition is preferable to that which was subsequently embodied in the

Bengal and Government of India Acts, which became law. The Bill empowered local Governments to establish retreats, to which lepers might voluntarily apply to be admitted for life or a term of years, being liable to punishment if afterwards they escaped from them, and to which vagrant lepers might be sent by magistrates for detention. Provision was made for the inspection and management of these retreats, in which, by a further provision, the sexes were to be separated from each other. Local bodies were empowered to spend money on such retreats, and local Governments were authorised to devote to them any moneys which they held at their disposal for expenditure on hospitals or asylums.

It may be observed here that the Government of the Central Provinces had, in the previous year, asked the Government of India to include powers for the compulsory detention of lepers in the Municipal Bill for those provinces which was at the time before the Supreme Government.

The reports on this draft Bill were on the whole unfavourable to it. Particular stress was laid on the circumstance that it contained no adequate provision for dealing with rich lepers. The Bill was not proceeded with.

In January, 1890, the Government of Bombay laid their hand upon an Act, to which their attention had been drawn some time before by their solicitor, and on the strength of which the asylum at Matoonga was afterwards established. This was Bombay Act VI. of 1867. It does not appear that the Government realised how this Act might be used to supplement or supersede the insufficent coercive provisions of the City of Bombay Municipal Act. The writer thinks that this discovery was left for him to make. But it was useful, and used for other collateral purposes.

The Act is entitled "An Act for the better sanitary regulation of the City of Bombay," and the preamble states that it is intended to have special reference to vessels using the port. It gave Government power to establish by notification sanitaria "for the segregation of persons suffering from any infectious disease dangerous to life," and to notify what diseases should be held to be such for the purposes of the Act.

On 8th January, 1890, the Government issued a notification, declaring "black leprosy" to be an infectious disease dangerous to life, and further declaring the asylums at Trombay and at Ratnagiri to be sanitaria under the Act. Three weeks later they required of the Police Commissioner of the city that he should deal with the evil, inasmuch as "places had been provided for the treatment of leprosy."

Now the Trombay Asylum would hold comfortably 18 or 20 patients, and at a pinch 25; the Ratnagiri Asylum would hold at the outside 80. Moreover, Ratnagiri was distant 12 miles from Bombay by sea, and was almost inaccessible for a sick person, certainly for a crowd of them, by land. There were, ex hypothesi, at least 800 lepers in Bombay. Even if Ratnagiri could be reached, yet the asylums there and at Trombay would together hold only an eighth of them. The action of the Government opened no way out of the impasse. The Police Commissioner was ordered to make bricks without straw.

At this juncture, Sir Dinshaw Petit offered one lakh of rupees for the erection of a leper asylum, on the conditions that it should be called after his name, and that the Corporation or Government, or both, should equip and maintain it. The Corporation agreed to the terms, but hoped Government would contribute. On 25th March, 1890, the foundation-stone of this asylum was laid at Trombay by an illustrious prince, who was then visiting India, and whose early death no long time after threw the whole empire into mourning. Plans and estimates were ordered to be prepared, the accommodation to provide for 1,000 lepers.

It may be observed here that no part of the money has ever been spent, and that the scheme has never advanced from that day to this. It was found, to begin with, that accommodation for 1,000 lepers in buildings sufficiently solid, and, if I may use the word "pucka," to satisfy the Government engineer, would cost nearer five lakhs than one, and the necessary funds were not available. While the plans were being considered, and during the pause which ensued on this discovery, the asylum at Matoonga, intended at first as a temporary expedient to bridge over the period till the new asylum at Trombay should be ready, was started, enlarged, and gradually acquired its present permanent character, and for various reasons, among others, the much greater convenience of the situation, has superseded the Trombay scheme altogether.

The writer succeeded to the office of Municipal Commissioner of Bombay on 1st May, 1890. It was by that time becoming very plain that a long time must certainly

lapse before the asylum at Trombay could be uilt, if ever it was built, and the question of hat to do with the lepers of the city was every ay more and more pressing.

The writer has no intention of dwelling at ny length upon the measures which he took to ispose of the difficulty. It was soon clear to im that the best, indeed the only, course was elicit from the public charity—that charity hich the natives of Her Majesty's Indian mpire always and everywhere so nobly show hen the necessity for it has been made clear them—funds sufficient to provide a temorary home for vagrant lepers, until the xpected permanent accommodation was ready. would be egotistical, and would interest obody except himself, to recount the measures e took towards this end. It suffices to say iat by a sustained and organised effort funds ere raised, funds in the issue considerably xceeding the sum offered to Government by ir Dinshaw Petit. But the raising of these nds was the least and the easiest portion of ie undertaking. Two things presented themelves as difficulties requiring preliminary soluon, one the question of maintenance, the her the far greater and wider question of gregation. As regards the first, the writer pplied to Government and to the Municipal orporation to guarantee a certain monthly im per head of lepers received into the sylum. In each case a generous response as made. Government and the Corporation ach agreed to contribute Rs. 10 per head up the number of 150 lepers, or a joint total 300. In mentioning this, the writer must eeds mention the names of Lord Harris, then overnor of Bombay, and of Mr. Pherozeshah I. Mehta, now the Hon. Pherozeshah M. Iehta, C.I.E. Lord Harris was the first, and very liberal, subscriber to the fund, and iough the writer cannot assert, yet he has o doubt, that it was primarily to his influence iat he owed the consent of Government to the rge contribution they made towards maintennce. He owed a similar debt in the Corporaon to Mr. Mehta, and here he has a full nowledge of all that passed, and is able to ate that, generously disposed as the Corporaon undoubtedly were, yet it was to Mr. Iehta's commanding influence and ability iat he is principally indebted for the readiness f their response to his appeal.

The question of segregation seemed for a ng time to be an insuperable difficulty. The hief object to be aimed at was the purgation f the city. To this end a voluntary asylum would have been useless. If lepers were to come and go, the streets would never be clear of them. At all times the majority, on each of the numerous occasions of a festival all of them, would infest the streets as before, begging and exhibiting their deformities. It was absolutely necessary, if any good was to be done, that the real crux of the leper question, which had never yet been grappled with, and on which every scheme had hitherto been wrecked, should be resolutely and decisively faced, and disposed of.

It was clear that in the Municipal Act no help was to be found. After other vain explorations in the arcana of legislative enactments, Act VI. of 1867 (Bombay) was turned to, and after careful study, it seemed to give all the necessary power. Under the third section of the Act, the Consulting Officer of Health, or in his absence, the Health Officer of the port, had the power to remove any vagrant who might be suffering from a disease notified under Section 12, to a sanatorium notified under Section 1; and any person so removed was "*bound to remain there until one of the said Officers of Health certified that he might go abroad without danger to the public.*" Now, over the Health Officer of the port the Municipal Commissioner had no control, but under Section 76 of the Municipal Act the Health Officer of the Municipality was made Consulting Officer of Health for the purposes of Act VI. of 1867. The Health Officer of the Municipality was subordinate to, and was indeed the head of one of the departments under, the Municipal Commissioner. The writer, who filled the latter office, began, therefore, to see his way sufficiently clearly to justify him in proceeding to collect subscriptions. As soon as a certain sum had been realised, building was begun. The site chosen was at the village or suburb of Matoonga, within the limits of the city, but on its further boundary, and near the head of the harbour. Though not far from one of the main roads leading northward out of the city, it was completely concealed from it, and was, in fact, so effectually isolated, that, as the Health Officer oberved, it was "anatomically twenty miles from the city." In former days troops had been quartered at the place, and the long high embankments or plinths upon which the barracks had stood were very suitable for the erection of wards, and their existence saved much expense. The ground belonged to the Municipality, and it was not the least of the services of the Corporation to the cause that

they never demurred to its occupation, which the writer had no authority to have effected without their previous concurrence. But in all matters connected with the leper asylum, the Corporation of Bombay have shown a large and noble liberality.

The asylum was at first intended to be of a temporary character, but if it was to resist the monsoon of Bombay, strength was essential. Economy also was a primary requisite. The plans and the character of the structure were the work of the Municipal Chief Engineer, Mr. Rienzi Walton, now one of the Engineering Inspectors of the Local Government Board, without whose talent and energy the buildings could not have been erected so quickly as they were, or on such satisfactory lines. Though at first called temporary, and constructed to a great extent of iron (angle and T irons with brick noggin), so as to be easily removed, they may, as a matter of fact, defy the wear and tear of centuries.

The wards, with all their adjuncts, which now include, besides lavatories, storehouses, dispensary, and so on, a Hindu temple, a Mohammedan mosque, a Roman Catholic church, and a very useful hospital ward (built at the cost of the benevolent Bai Dinbai, widow of Mr. Nusserwanjee M. Petit), cover several acres of ground, and are surrounded by a high fence of barbed wire.

On the 6th November, 1890, sufficient work had been done, though building had only begun on 19th August previous, to provide accommodation for somewhat less than 100 lepers. Those who were concerned with it will not forget that day, the first on which compulsory segregation was applied to lepers in India. The police had received due warning, and the necessary orders had been issued by their Commissioner, whose valuable co-operation had been readily secured. On the morning of the 6th of November, 40 or 50 lepers were brought in by the police from the streets, and conducted to a locality where they were to be inspected by the Health Officer (Surgeon-Major Kirtikar). They were all carefully examined, the necessary certificates were issued, and they were removed in carts (afterwards carefully disinfected) to the Matoonga Asylum. On the next day similar action was taken, and so on, until the available space was filled. As the asylum grew, further removals took place, and when the writer left India in April, 1895, the full number of 300 was rather exceeded; there were about 310 patients in the asylum.

Two sets of prophecies attended the establishment of the Matoonga Asylum; one, that it would be so popular that it would soon be over-crowded; the other, that it would be impossible to coerce the lepers into staying there. Both have proved wide of the truth, though the former is nearer to the facts than the latter.

The asylum became in course of time sufficiently popular to keep it filled, and even a little more than filled. It did happen now and then that a leper seeking admission had to be turned away, but these were occasional cases. Room was always found for lepers sent there by the police. It must be understood that after the first few months the intervention of the police was confined to sending to the asylum casual vagrants arrested for begging, and who would, if they had not been lepers, have been placed before a magistrate.

In its earlier days, the asylum was distinctly unpopular. The wholesale sweeping up of lepers from the streets, and the confinement of the asylum were both resented. The writer was once disposed to attribute the diminished number of lepers in the city, which was disclosed by the census taken in February, 1891, four months after the asylum had started, to an exodus caused by the coercive measures which had been adopted; but though he still thinks there was some ground for that belief, he has since come to the opinion that he exaggerated it, and that though a few lepers may have left Bombay on that account, yet the real fact was that both he himself and all the other authorities of the city at that time had over-estimated the number of lepers within it. He has already referred to the Police Commissioner's estimate that there were at least double as many in 1889 as there were in 1881, and no one put the number at less than 800 to 1,000. But the writer greatly doubts whether 500 would not have been an over-estimate. The writer never thought or said at any time that he believed leprosy to be on the increase in India; but he did believe that with the improvement of communications both by land and sea, the natural gravitation towards a great city, that is, towards a convenient centre for begging, had added to the number of lepers in Bombay itself. He still thinks it had done so, but not to anything like the extent which he at one time supposed to be the case.

The Matoonga Asylum, however, built to contain 300 patients, might reasonably be enlarged so as to contain 500.

For some weeks after the asylum was established, it was thought advisable to keep a

small guard of police there. But in spite of this, and in spite of the fact that it was surrounded by an 8 foot fence of barbed wire, there were several cases of escape from it in the first few weeks, perhaps a dozen from first to last, and there was a good deal of discontent within the asylum. The truth is that confirmed habits of vagrancy are difficult to eradicate, and that lepers, like tramps in this country, prefer a life of freedom and irresponsibility, though it be one in which their sustenance is precarious, to regular habits, and sufficient food and clothing, coupled with restraint, however lightly applied. Perhaps the vagrant leper may often have passed a day or two without a full meal, but then he very often got opium, sweetmeats, and other luxuries, and forgot his sufferings in the enjoyment of them. It is true that when the pinch of privation was severe, large numbers would have voluntarily sought the asylum; but after good feeding for a day or two they would have left it again, and resorted to their former wandering habits. For this reason a voluntary asylum in India will never clear a place of lepers, and as a matter of fact, never has done so. There is, for instance, a most admirable leper asylum at Madras, constructed on the best lines, and managed to perfection; but when the writer visited it (in March, 1891), he found the streets of Madras full of lepers.

One difficulty which was felt at the Matoonga Asylum, when first started, arose from the opium-eating habits of the patients, and though the writer for a short time adhered to the resolve not to allow the issue of opium, he had at last to give way, and small and diminishing quantities were allowed under the strict control of the medical officer. It was found possible to reduce the quantities by degrees, and the habit was gradually almost or altogether eradicated.

Every effort was of course made to render the asylum as comfortable a residence as possible. The diet was on the most liberal scale, the clothing was excellent, tobacco was allowed to both men and women who cared to have it, and the strictest regard was paid to cleanliness. At the same time, every remedy, medical and surgical, by which the misery of the patients could be alleviated, was at their disposal. A medical officer lived on the spot, and he was under the control of a doctor of superior rank and attainments, who daily spent from two to three hours at the asylum. The latter again was under the orders of the Health Officer to the Municipality. The whole asylum was directly ruled by the Municipal Commissioner.

After a few weeks, it was found possible to remove the police guard; and as the reputation of the asylum grew among those whom it was intended to serve, as they learned how greatly health and comfort were promoted by residence there, and how ample a measure of freedom they might still possess within its wide boundaries, attempts to escape came entirely to an end, and the difficulty of finding room for those who wished to come in was substituted for the difficulty of retaining them there.

All classes of natives were admitted, and there were from time to time a very few Europeans. A question soon arose as to providing for the spiritual requirements of the inmates. The writer did not feel at liberty to do this out of the general funds collected for the erection of the asylum. He, therefore, made special appeals to Hindu, Mohammedan, and Christian gentlemen; and out of the funds by them contributed for the purpose, he built a small Hindu temple, properly fitted up, a small mosque, and a small Roman Catholic church, and suitable arrangements were made for the attendance of priests of the different religions. The writer's action in this respect exposed him to some comment, and he was accused of furthering the cause of idolatry; but for such accusation he cared and cares little. The inmates of the asylum were, without having committed any crime, prisoners for life, and he felt it to be his clear and sacred duty to provide, so far as he could, for all their legitimate requirements; and he thought, and thinks, that the claims of a Hindu or a Mohammedan for a place of worship according to his belief, was a requirement as legitimate as that of a Christian for a church.

Perhaps the most painful feature of the asylum was the large number of children which it contained. These amounted at last to 30 or 40, from five or six years of age upwards. Every species of game and toy that could be devised was provided for them, and added to from time to time; and though education would be of little use to them, it was thought well to occupy their minds by giving them some schooling. A small school was accordingly built; schoolmasters were easily found among the lepers, and four hours' schooling a day, excepting during the holidays, was insisted on. Examinations were periodically held with as much show and circumstance as possible, and public prize-givings, often attended by many of the principal ladies and gentlemen of the city,

succeeded to them. It was easy to raise money for these prizes from the benevolent, and it was contrived, contrary to all sound educational principle, that all the children should receive some prize or other. The last prize-giving which was held before the writer left India, was presided over by the Right Rev. Dr. Mylne, Bishop of Bombay, to whom the writer was greatly indebted, not only for his kindness in consenting to preside but also for the excellent speech which he made to the children in the Marathi language, a feat which not many of the chaplains under him could have emulated.

But for the institution of the school the condition of the children would have been far more miserable than it was. It gave them something to think about, and take a solid and abiding interest in, saved them from brooding, and gave zest to their play hours. The writer considers that if they were kept tolerably happy, it was chiefly the school to which they owed it.

During the years following the establishment of the Matoonga Asylum, the writer had some friendly controversy with the Army Sanitary Commissioners on the question of compulsory segregation; that is to say they condemned it in some of their reports, and he replied to them in his annual Administration Report. It might seem that a layman can be but ill-equipped for such a combat with leaders in the medical profession, but, as before remarked, what the layman has to do is not to solve medical problems, but to seek a hypothesis upon which action may be based, and, believing the problem before him to be one of an administrative character, the writer maintained and preferred his own opinion even to that of the Army Sanitary Commissioners. The latter, in reviewing the sanitary condition of Bombay in 1889-90, dealt with the question of leprosy, and deprecated compulsory segregation, on the grounds that the benefit to the community at large would be small, the expense would be great, and the interference with liberty would cause great injustice. On the last two points a practical administrator is probably a better judge than a medical man; at all events, they are clearly questions for the former. As regards the first, if it is correct, it is difficult, nay, impossible. to understand why voluntary isolation should be recommended by the Leprosy Commission, or any interference with lepers in their trades, even though those trades do concern human food, drink, or clothing. If isolation is *per se* of value, it cannot matter, medically, wheth it is voluntary or compulsory. How the isol is to be effected does not seem to be a que tion for the profession. Given isolation as end to be achieved, the method by which it to be achieved is a question for administrati not medical, science. Suppose the Arr Sanitary Commissioners to have been in favo of compulsory isolation, would they ha thought it part of their function to prescribe the writer the agency which he was to empl to enforce it, or to dictate whether such agen was to be that of the police or of the Muni pality?

The Army Sanitary Commissioners, in later report, recurred to the subject, and s they had thought, and were still of the opinic that compulsory segregation would cause mu mischief. To this the writer replied in 18 that the Matoonga Asylum had, at the date f writing, been in existence for more than thi years; that it was idle to employ hypothe when facts were at hand; and that if any m-chief had been caused by compulsory segreg-tion, it would be possible to prove it from t example of the Matoonga Asylum. He add that the Bengal Government were then co-sidering a Bill for the compulsory segregat of lepers (the Bill which has since become la, and which had been sent to the writer for co-ment and opinion by the Bengal Governme, and that a fact of that sort, which showed t t the responsible administrators of another p-vince believed that an example had been se Bombay which it was wise to follow was w a thousand theories to the contrary.

It need hardly now be repeated that e example set at Matoonga has germinated d spread, and that not only have the Ben l Government passed an Act on the subject, t that the Government of India, in direct op-sition to the advice of the Leprosy Commissi, have passed "an Imperial Act, especi y directed against lepers, as such," though e expression "directed against" does not se n a happy one.

A plain and simple narrative has been gi n of the establishment of the Matoonga Asyl, and it will be seen that it was incor t to say that that asylum was built y the Government of Bombay, out of fu s contributed by Sir Dinshaw Petit. It s built by the writer out of funds collected y him. He claims no credit for having b lt a leper asylum. Any energetic person in e position he then occupied could have collec d money and built an asylum; but such a st-

-, if it had been no more than a hospital or ne, would have been as useless, considered a means of delivering the city from an lerable pest, as every other asylum in India the time was. The real peculiarity which erentiated Matoonga from all other asylums, l which furnished first Bengal, and then the preme Government, with an administrative del, was that the principle of compulsion s in it first applied. There had been scores leper asylums for years all over India, but ie of them had brought this great question inch nearer to solution. The Matoonga ylum solved it, and has done so in the teeth the medical profession. The writer hopes may be pardoned for saying that he could peruse Sir J. Woodburn's speech (which first saw in January last), without some ling of astonishment; and that he had a right expect that his services to the country in s connection would not have been so com-tely forgotten.

Having regard to the fact that from the atoonga Asylum has sprung the whole rosy legislation of India, it will not be ught that too much time has been spent on that asylum. The writer wishes now to y a few words on the general question of mpulsory segregation, to which India has en committed. The serious fact in connec-n therewith is that the medical profession e almost unanimously opposed to it. It is nost impossible to deal with the question thout some reference to the further question contagion, with regard to which, however, e writer feels his incapacity, and would cline disputation with a medical man as together *impar congressus*.

The writer may be here allowed to digress a moment to recount an incident which ade at the time a considerable impression on s mind. When the Leprosy Commission st came to Bombay, at which time the atoonga Asylum had been established, they urteously called at the Municipal Com-issioner's Office, and the writer pointed out them the Act under which leprosy had been otified as "an infectious disease, dangerous life." On his calling their attention to the ords, one of them asked with a smile, "Who as the bold person who called leprosy an fectious disease?" The only reply that ould then be made was that the word in-ctious must be read in a popular and general ense, as meaning communicable; but the ggestion that leprosy could not, with pro-riety, be termed infectious, caused a very uneasy feeling; for, if it could not, the whole fabric of the Matoonga Asylum and its regulations would fall to pieces. Under no other law than this Act was it humanly possibly to enforce segregation—it could not be enforced unless leprosy could be notified under the Act—and if leprosy was not an infectious disease, the notification already issued was bad *ab initio*, and all that had been done under it lawless and actionable. The Matoonga Asylum was open to any respectable visitor, and who knew how soon some sharp solicitor might get hold of an aggrieved leper, and bring an action for false imprisonment, on the ground that leprosy was not an infectious disease, and, therefore, not notifiable under Act VI. of 1867? Luckily, nothing came of it, and doubts were dissipated by time.

But is leprosy not an infectious disease? Drs. Hansen and Looft, in their monograph on leprosy, published (at least the translation was) in 1895, seem to use the term "infectious" as synonymous with communicable. That is to say the Norwegian word that they use has been translated "infectious." They say that there is no course open but to assume that leprosy is infectious, that leprosy may be "caught" by inoculation, that as bacilli cannot be destroyed the only thing to do is to prevent "infection," and that this can only be done by isolation.

In a contribution to the "Journal of the National Leprosy Fund," Dr. Beavan Rake (one of the Leprosy Commissioners) speaks of "infected foci." Other instances of the use of the word by medical men may be quoted, sufficient, probably, to justify the use of it in connection with leprosy in an Act of the Legislature.

To what extent the medical world is divided on the question of the contagiousness or otherwise of leprosy, the writer is hardly in a position to judge. It is noticeable that the Leprosy Commissioners, while they discard the theory of hereditary transmission, consider that, scientifically, leprosy must be regarded as contagious, though the extent to which it is propagated by contagion is exceedingly small, and that in the great majority of cases leprosy originates *de novo*, that is, "from a sequence or concurrence of causes and conditions which are related to each other in ways imperfectly known." In referring to this oracular pronouncement, Dr. G. A. Hansen remarks (*Lancet*, October, 1893) that it would have been more straightforward to say at once that it was not known how leprosy originated, than

to pretend to know something about it; and to a plain mind the criticism seems not unfair. The Commissioners further remark that leprosy is not originated by insanitary surroundings, though it is "indirectly influenced" by them as increasing susceptibility to the disease. This again does not seem to take us much further. Of course, a weak man is more easily knocked down than a strong one.

There appears to have been much difference of opinion on the question how far the measures adopted to combat leprosy in the Middle Ages were the real agents in expelling, or almost expelling, the disease from Europe. It has been, no doubt, popularly supposed that the isolation of lepers, which was at one time generally, and often harshly and cruelly, enforced in England and in Europe, was the cause of this successful result; but many, perhaps most, medical authorities seem to think that improved hygienic conditions were in reality responsible for it. Dr. Vandyke Carter, however, concurred in the common and popular view. It is difficult to mention this name without paying a tribute to it. Of all Indian authorities upon leprosy he is surely by far the foremost. It is refreshing and ennobling to read his many contributions to the literature of the question, to study the masterly capacity with which he arrays his facts, the extraordinary acuteness with which he sifts them, the combined clearness and caution of his conclusions, above all, the earnest unwavering persistence with which he strives after truth; never the advocate for a moment of any special fad or theory, firm in his opinions, because they are based on facts and sound deduction, but always ready to yield to wider knowledge and sounder reason, continually striving after the light with a large and liberal recognition of the claims of practice as well as theory. Dr. Vandyke Carter did not believe that hygienic improvement accounted for the decline and practical extirpation of leprosy in the Middle Ages. He says,* in 1871:—"The ban under which lepers were put in Europe had the greatest influence in eradicating the disease—it may be said it was thus stamped out. To mention the old harsh leper laws, except with deprecation, might not be acceptable, yet, if the only alternative to their partial imitation be the hope thus expressed in the report of the late London Committee" (Committee of the Royal College of Physicians, June, 1862), "that a marked change in the habits of the population of India will en[...] upon the increase of divers industries, the [...]proved cultivation of land, the less frequ[...] recurrence of famines, and the consequ[...] general amelioration of their condition fr[...] year to year, and that better food, be[...] clothing, better housing, with greater perso[...] cleanliness, will lead to the abatement [...] leprosy; then, indeed, the outcome of a m[...] elaborate official inquiry does seem disp[...]portionate." He goes on—"To realise [...] needs and remedies of India on this subj[...], some practical acquaintance with the coun[...], which the Committee of the Royal Colleg[...] Physicians have not enjoyed, is an essen[...] prerequisite." He might well say so. [...] those of us who have been brought into cl[...] contact with leprosy in India—and what [...]trict officer or resident in a great town has n[...]? —it seems the merest trifling to argue that [...] are to wait till the general improvement of [...] physical condition and sanitary surroundi[...] of more than 300,000,000 of people has ex[...]pated the disease.

In 1873, Dr. Vandyke Carter wrote a rep[...] on "Leprosy, and Leper Asylums in Norwa[...]" in which he says:—"In my opinion [...] decline of leprosy in Europe was mainly du[...] segregation, harshly and badly carried out [...] it was, and there is no essential connect[...] between leprosy and bad sanitation. [...] Norway there has been no such general [...]provement in the condition of the people [...] would account for the decline in leprosy. I[...] due to asylums and segregation." He c[...]tinues (and the sentiments expressed are [...] just and noble that the quotation must [...] allowed), "It is most desirable to remove fr[...] the sight of and contact with healthy m[...], women, and children, the diseased and rep[...]sive leper . . . Familiar contact with [...] loathsome malady can have but one effect [...] young and old, when not accompanied, as [...] an asylum, by constant efforts to palliate [...] cure. . . . Passive tolerance of fright[...] disease is surely the work of blunted sy[...]pathies, or worse, of reprehensible indifferen[...], failings in the long run which cannot but re[...] on the community. . . . Much of the [...]difference to suffering, which we often won[...] at among the Hindus, is due to persistence [...] the conditions now hinted at. On the br[...] grounds of social policy they should be de[...] with."

The curious point is that when Dr. Vand[...] Carter expressed these strong opinions as [...] the value of segregation he was not a belie[...]

* Transactions, Bombay Medical and Physical Society, No. XI., p. 74.

ıe diffusion of leprosy by contagion. The radiction between theory and practice in nind is very striking. As a medical man, vould not go an inch beyond where the ence led him; but, as a practical adviser of ernment, he was able to free himself from trammels of mathematical demonstration. was the master of logic, not its slave.

t a later date, viz., in 1876, in reporting on ·prosy in Kattiawar," he wrote as follows: Leprosy flourishes, but does not arise ıng bad hygienic conditions. I am in- ›osed to admit that leprosy ever arises ıtaneously; it can, therefore, only be pro- ated by contagion, or by hereditary trans- sion. There is a good deal of negative lence against contagion. I am disposed to ch more weight to positive evidence . . . ct upon the presumption most favourable to interests of society in general . . . ." speaks with great caution and reserve.) . "Heredity, as the exclusive agent in propagation of leprosy does not seem to be itled to the position once allotted to it." t he had been once a powerful advocate of theory of heredity; his judicial wisdom is eedingly striking). . . . "In Kattiawar disease persists in the midst of a general sperity, and in spite of the improvement of people. . . . My plan is the complete ation of the leper, and, if possible, his ıoval to an asylum. . . . I suggest (*a*) ıvenient refuges for vagrant lepers who are be detained in them; (*b*) similar asylums ·n to the poor who are not vagrants, and ich they should be compelled to enter; (*c*) .t persons who are willing to provide separate intenance for their lepers should only be ›wed to do so on condition that isolation be cient."

This is almost the same system as has been ›pted in Norway, partly before and partly ce Dr. Vandyke Carter made these recom- ndations. It will be convenient now to turn Norway, which furnishes the best modern dence as to the value or otherwise of lation.

The publications of Dr. G. A. Hansen, the spector-General of Leper Asylums (or of prosy—the writer is not sure what the exact ·e is) have already been more than once erred to. He published in October, 1893, a ›rt article in the *Lancet* commenting on the ›ort of the Leprosy Commissioners. In that icle he makes nearly the same remark as ·ndyke Carter makes when considering the estion of contagion, that one bit of positive evidence is worth a thousand negatives. But without dwelling at this point on Dr. Hansen's opinions, it will be better to look for a moment at his facts and figures. The general truth of the observation that figures may be made to prove anything may be admitted, but facts in the shape of figures nevertheless furnish the best quality of evidence when they are studied with the desire, not to manipulate them in favour of a preconceived theory, but to obtain light from them upon the path of truth.

In a monograph on leprosy, published in 1895 (which has been already referred to) by Drs. Hansen and Looft (the latter being assistant physician at a great hospital) a tabular statement is included, which shows

Year.	Total Lepers at beginning of year.	New cases.	Result.					Total at end of year.	Proportion in Asylums to total at beginning of year.
			Died.	Cured.	Emigrated.	At home.	In Asylums.		
1856	—	238	—	—	—	2,598	235	2,833	—
1857	2,833	242	293	3	15	2,339	427	2,766	15·07
1858	2,766	210	224	3	3	2,294	475	2,769	17·17
1859	2,769	239	213	8	7	2,267	523	2,790	18·88
1860	2,790	219	251	1	6	2,218	539	2,757	19·31
1861	3,757	219	239	6	14	2,028	711	2,739	25·77
1862	2,739	211	215	5	11	2,009	698	2,707	25·55
1863	2,707	196	192	5	4	1,947	749	2,696	27·66
1864	2,696	201	202	—	8	1,914	781	2,695	28·98
1865	2,695	201	205	5	8	1,910	772	2,682	28·64
1866	2,682	203	214	3	10	1,879	795	2,674	29·64
1867	2,674	200	191	8	4	1,876	787	2,663	29·43
1868	2,663	206	210	6	7	1,865	788	2,653	29·59
1869	2,653	183	199	10	13	1,820	787	2,607	29·62
1870	2,607	187	203	3	13	1,762	764	2,526	29·30
1871	2,526	170	238	2	16	1,681	747	2,428	29·57
1872	2,428	131	205	5	10	1,627	708	2,335	29·10
1873	2,335	129	177	9	17	1,592	672	2,264	28·77
1874	2,264	137	183	6	9	1,566	642	2,209	28·35
1875	2,209	134	203	5	14	1,499	623	2,122	28·20
1876	2,122	115	187	3	6	1,440	613	2,053	28·88
1877	2,053	110	163	3	7	1,372	629	2,001	30·63
1878	2,001	105	149	10	8	1,341	618	1,959	30·88
1879	1,959	88	162	5	10	1,277	602	1,879	30·73
1880	1,879	72	150	7	7	1,178	617	1,795	32·83
1881	1,795	60	164	5	8	1,092	608	1,692	33·87
1882	1,692	66	137	11	7	1,061	553	1,614	32·68
1883	1,614	87	127	9	5	1,022	535	1,557	33·14
1884	1,557	55	140	10	2	944	519	1,463	33·71
1885	1,463	71	146	9	12	855	522	1,377	35·08
1886	1,377	48	135	16	9	748	522	1,270	37·90
1887	1,270	47	111	2	3	704	514	1,218	40·47
1888	1,218	27	99	8	1	631	524	1,156	42·94
1889	1,156	27	86	9	12	551	530	1,081	45·04
1890	1,081	10	122	6	2	447	507	954	45·97

year by year from 1856 to 1890 the number of lepers in Norway, the number of new cases, the deductions by death, cure, and emigration, the admissions to asylums, the number remaining at home, and finally the total of lepers in Norway at the end of the year. It is believed

that the statistics are absolutely accurate. As Dr. Hansen says: "Every leper in Norway is known by name." There were 2,833 lepers in Norway at the end of the year 1856, when asylums were first established, and the system of isolation entered on tentatively and imperfectly. At the end of the year 1890, the lepers of Norway were 954; in the year 1894 Dr. Hansen says they were 700.

A study of the Table will show that from the time that the system of isolation was resorted to, partial and incomplete as it was, at all events at first, there has been a steady decrease in the number of lepers in Norway, not absolutely year by year, but practically so. There were only two years, 1858 and 1859, in which the number of lepers exceeded—very slightly—the number of the previous year. In 1858, there were three more than in 1857; in 1859, there were 21 more than in 1858. With these exceptions every year shows a steady decline.

The writer has added a column to this Table, in which he shows for each year the proportion out of the total number of lepers in the country at the beginning of each year, who had been isolated in asylums. It seems to him that this is an useful addition to make. Looking at the absolute figures alone, without taking out their relations to each other, might give an erroneous impression as to the extent to which asylums have been made use of. Thus in

1857	there were	427	lepers	in asylums.
1867	"	787	"	"
1877	"	629	"	"
1887	"	514	"	"
1890	"	507	"	"

One might conclude from this that the value of isolation was less and less felt by the people, and less and less insisted on by the authorities as time went on, but such a view would be quite erroneous, inasmuch as it would leave out of account the diminishing number of lepers in the country. Thus the proportion of lepers isolated in asylums, to the total number in the country at the beginning of each of the above years, was:—

1857	15·07
1867	29·43
1877	30·63
1887	40·47
1890	45·97

A study of the Table will show that from 1857 to 1866 the proportions of lepers in asylums rose rapidly; there was then for some years a pause, and even a slight decline; in 1876, for instance, the proportion was 2 8, against 29·64 in 1866; but there was th a fresh start, and after 1876 the proportion n er went back, except very slightly in 1882; he progress was steady and continuous, till at at the end of 1890, it had risen to over 5 er cent. The total lepers in the country re 954, of which 507 were in asylums.

The writer was hardly prepared for su a result when he began to extract the pro r-tions. Among a people like the Norwegi s, comparatively highly educated and civili d, it was to be expected that the value of is a-tion would be so fully appreciated that it w ld be largely enforced at home, without y necessity for resort to an asylum. This d evidently been the case to some extent, but ot so much so as to check the growing beli in the value of asylums, not only as place of isolation, but, no doubt, also as place of medical relief. Examining the statistics s-trict by district, Drs. Hansen and Looft p nt out that the decrease in the disease in e h district depended on and succeeded to e numbers isolated in asylums. "Where is a-tion was insufficient or absent, there was l le or no decrease, where it was thorough a e-crease was invariable." The same thing nt on through each quinquennium (they cons e the figures for quinquennial periods, whic is more satisfactory than taking them yea y year, as it reduces the effect of casual caus); as the numbers of lepers remaining in t i homes were reduced, so were the "centre o infection" diminished, and the number o new cases were continually lessened. take the same years as have been alre y quoted, the numbers of new cases were:—

In 1857	242
1867	200
1877	110
1887	47
1890	10

If isolation is of no value what do t facts mean? Dr. Hansen is, of course strong contagionist; but the writer has noth to say on his own account on that point. will once more, however, quote the view a great authority against contagion, Vandyke Carter. He says in his report Leprosy in Norway:—"There has been such general improvement in the conditio the people of Norway as would account for decrease of leprosy. It is due to asylums segregation. . . . The detention of lepers asylums leads to the diminution of the dise outside asylums. This can only arise in

er, by the abstraction along with the of some injurious influence appertaining itself. . . . Asylums in Norway were first ished under the belief that leprosy was tary, but whether transmissible by here- or contagion, asylums are equally use- This was written in 1873, when the er of lepers in Norway was still over Had Dr. Vandyke Carter seen the s now before us, he would have been even strongly convinced. During the first 17 from 1857-1873, the number of lepers way was reduced by about 500 ; during xt 17 years it was reduced by more than

Leprosy Commissioners, quoting Dr. . Collins (*Lancet*, May 17th, 1890), r to agree with him that "to attribute cline of leprosy in Norway to compulsory on is entirely erroneous. . . . I met lepers . . going about their usual ons." This seems to the writer to be trifling. It is not contended by any one complete system of compulsory isolation Had that been the case, probably Dr. n would say that leprosy would have stamped out years ago, and that it is eradicated only slowly and gradually, se isolation is only partial. Dr. Collins tes the decline to the material improve- of the people, which Dr. Vandyke Carter . The writer is unable to comprehend r. Collins's theory can be made to square gures and facts. They seem to him to conclusively in the other direction. If in e had had the facts of Norway, and the ence gained in that country before him, d of knowing nothing about them, the would have had a lighter heart in under- the responsibility of compulsory segre- in the Matoonga Asylum.

Hansen says, "Our statistics clearly strate that this result" (decrease in r of lepers) "has been brought about by on." The writer is unable to see what leduction from them is possible.

ppears that in Norway it was vagrant only that in former days were compelled r an asylum. But in 1885, a law was , at the instance of Dr. Hansen, provid- at every leper who chose to live at home have his own room, bedding, and eat- paratus, and have his clothes separately l. If he was unable to ensure these tions (and every leper was known by and was under the eye of the physician district), he was to be compelled to enter an asylum. The proportion of lepers in asylums rose very rapidly for some years after 1885, no doubt in consequence of this law.

There is one column in the tabular statement relating to Norway appended to this paper which will cause most laymen a good deal of surprise; that is the column headed "cured," which shows that 208 persons have been cured of leprosy between 1856 and 1890. The writer had always supposed the disease to be incurable. Drs. Hansen and Looft say, however: "Patients usually die before the disease has run its course. But in the maculo-anæsthetic form, the cure of the leprosy is almost invariably the result. What remains, however, after the cure of leprosy is very different. We have . . . . usually only a miserable rudiment of a human being, with more or less paralysed and deformed hands and feet, with unclosable eyes, of which the lower part of the cornea is opaque, and from which the tears run down over his cheeks, and with paralysed facial muscles, unable to close the mouth, so that the saliva constantly dribbles from it. Such cases may, however, live long and reach great ages, if such is an advantage." The leprosy is cured, but it leaves an animated, partially animated, corpse behind it. This awful picture, which is one only of many others equally awful which might be drawn of the results of leprosy, indicates where the justification really lies for speaking of the disease as an "Imperial danger." The phrase was much condemned when first used, as an unjustifiable exaggeration, and in so far as it was meant to convey that leprosy was dangerously on the increase, it was no doubt rightly condemned. But in its intensity and its fearful effects upon the human frame, though not in its wide diffusion, the disease may justly be spoken of as an Imperial danger.

The Governments of Bengal and of India, in legislating on this subject, made no reference to Norway, but appealed to the advice of the Leprosy Commissioners and the example of Bombay in justification of their action. But Norway seems to furnish as strong a case as a legislator need ask for of the value of isolation. And the Commissioners, after accumulating reasons to prove that isolation is of no use, and quoting authorities in support of that view, end by recommending it. It is true they do so in a half-hearted way. They deprecate compulsory, they advise voluntary isolation. But isolation is isolation, whether compulsory or voluntary, and seems to be justifiable only on the ground that the leper, to use Vandyke

Carter's words, carries about with him some noxious influence "appertaining to himself." If this is so, the isolation ought to be as complete as it can be made, having regard to all the circumstances which should be considered in fixing a limit to it.

Voluntary isolation in India may be pronounced to be impracticable and useless. Neither intelligent appreciation of its advantages, nor a sense of obligation to society can be expected where education and anything resembling a high standard of civilisation are so meagrely diffused. Nor would it be possible, the area and population of the country being so vast as they are, that the watchful scrutiny of the medical man, which has been found so valuable in Norway, should be generally effective. The only resource, therefore, which is open to Government in India is to make isolation compulsory, if it is to be resorted to at all. This is what has now been done, the application of compulsion being confined to vagrant, or as they are called in the India Act of 1898, as well as the Bengal Act V. of 1895, "pauper lepers."

Both Acts contain definitions of the terms "leper" and "pauper leper." A leper is defined to be a person suffering "from any variety of leprosy, in whom the process of ulceration has commenced." In the draft Bill circulated by the Government of India in 1889, a leper was defined to be a "person certified . . . . to be suffering from leprosy." The writer has already remarked that he prefers the latter definition. When the Bengal Bill was sent to him for opinion, he submitted his reasons for preferring it, but his views were not in accordance with those of the medical advisers of the Government of Bengal, and afterwards of the Government of India, and they did not prevail. But he thought then, and continues to think now, that practical inconvenience may be caused by the narrower definition, which confines the term leper to persons in whom the process of ulceration has commenced. It may perhaps be true that the leper does not carry about "any noxious influence appertaining to himself," except when ulcers exist. But the writer's experience in Matoonga teaches him that on admission to an asylum where the patient is properly housed, clothed, fed, and medically treated, ulcers, unless very far advanced, generally close up. They re-appear, no doubt, but often not for months. If the leper is discharged, as no longer belonging to the statutory class of lepers, as soon as his ulcers are closed up, he will go out to beg again, the ulcers will sp re-open, he will again become the medi the "noxious influence" spoken of by Va Carter, and all the trouble and expense arresting him and re-conveying him t asylum will have to be gone through second time—or, indeed, for all the writer to the contrary, it may have to be gone th a dozen times. As soon as he is expos the unhealthy conditions of a vagrant li ulcers will re-appear. As soon as he come again under the palliative influence c asylum, they will close, and thus he wil tinually be oscillating between the outside and the asylum, until the disease is advanced as to resist all palliative treatr

It is true that the definition object classes every man as a leper in whom tion has "commenced;" and it may be that once ulceration has been discove patient is to be regarded as a leper t forward for ever; that a subsequent disa ance of the ulcers does not dispose of t that they once existed; and that a cl discharge on that ground could not be tained.

It is to be observed, however, that the of Inspection provided for by the Act po the power, and no doubt is expected to e the power, of discharging from an asylun leper who "can be released without haz inconvenience to the community." (Sect and Form E, Schedule to Act III. of Ex-hypothesi a leper is not a source of or inconvenience to the community unl process of ulceration has commenced. then, can he be detained if it has cease

But supposing the above objection invalid on the ground suggested, the would still venture to think that to leprosy within the limits expressed by tion is inexpedient, for a leper may, ar bably will, go free long after the pro ulceration has commenced, because, known to be a leper, it may not be disc or known that he is an ulcerated leper. the very danger against which the intended to guard is allowed to have wider operation than was at all necessa

It must be here added that to re vagrant leper, in whatever stage of the d into a properly constituted asylum such at Matoonga, is an act of kindness to well as to the community; at least, suc writer's firm opinion. If the inevitable ference with liberty" (Army Sanitary missioners) amounted to a hardship

eighed against the immense advantages
company it, it would be another thing
her. But the writer is convinced, and
aks from an intimate experience, that
n not the case. If the anxious and
regard to the comfort and happiness,
al and mental, of the patients, which
to be paid, and no doubt in all asylums
the Act, will be paid, is maintained,
ects of it will almost without exception
ery few day after admission, prefer the
hin to the life without. If this be so,
oral objection to making prisoners for
nnocent men (and the case cannot be
trongly stated than in these words) dis-
s entirely.

writer may, of course, be wrong in the
e takes of the possible consequences of
fining section of the Act. Time will
and he can only regret that he has so
portunities or possibilities of watching its
on.

her point in which the Act III. of 1898
is practically the same as the Bengal
of 1895) differs from the draft Bill of
s that it contains no provision for the
ation of the sexes.

889, laymen at large no doubt believed
heredity of leprosy. The writer most
ly did when, in the ensuing year, he
ated the sexes at Matoonga. But he
admit that if he were establishing an
now, he would be in a difficulty on
int. He does not in the least believe
the heredity of leprosy as a "working
esis," that is to say, in the hereditary
ission of the disease. But this belief or
ef does not exhaust the question of
segregation or the reverse. There can
doubt that if married lepers are allowed
together, and lepers in an asylum
l to marry, the amenities of such an
ion will be greatly increased. All ob-
on, it is true, seems to show that lepers
prolific; still some children will be born
n; and if contagion be under any cir-
nces possible, the close intercouse be-
parents and children, particularly
s and infants, will vastly increase the
of it. It is true that orphanages or
n's homes can be instituted, to which
fspring of leper parents interned in
s may be ultimately conveyed, but it
t be possible to separate the mother
e nursing infant. For some years, pro-
the child and the mother must continue
together in the most intimate association, and the chances are perhaps at least considerable, that under these circumstances, the child will become a leper, particularly when its other surroundings in a leper asylum are considered. This consideration furnishes an argument, though by no means a conclusive one, in favour of segregating the sexes. The advantages and disadvantages on both sides have to be carefully weighed, and, of course, were carefully weighed by the Government of India before it determined to exclude from the Act of 1898 the provision for sexual isolation which the earlier Bill had contained. All that the writer wishes to point out is that the question is not disposed of by a repudiation of the theory of the hereditary transmission of leprosy.

The Act of 1898 contains a certain number of restrictive provisions which debar a leper from preparing or selling food, drink, or clothing, from bathing or washing in the public wells or tanks, and from using public conveyances. Under the City of Bombay Municipal Act of 1888 a considerable advance had already been made in this direction. Persons suffering from contagious diseases are debarred (Section 38 of that Act) from using public wells, tanks, standpipes, &c., by Section 428 from using public conveyances, and the Municipal Commissioner, under Section 410, and others, possesses considerable power of control over the sale of articles of food. But the Municipality will, no doubt, find it to their interest, if they have not already done so, to move the Local Government to supplement the provisions of the existing law by notifications imposing further and more precise restrictions, such as it is empowered to issue under Section 9 of the Lepers Act.

There is one other point to which the writer would wish to refer. Dr. Hansen's law of 1885, under which lepers not wishing to enter an asylum, are compelled to give guarantees for efficient isolation at home, has been already referred to. This provision makes the law in Norway complete by embracing every class of lepers, the rich and poor alike. Nothing of the sort has yet been attempted in India. It would be very desirable to do it if possible; but is it possible? Independently of the extent of the country and population, the extreme difficulty and delicacy of any inquisitorial law which invades domestic privacy, are very serious obstacles. It is true that the public opinion of the country would be on the side of Government if any such attempt were made. The people of India do believe in the segregation of lepers. Possibly, as time goes on, it may be

practicable to make, with extreme care and caution, some advance in this direction, to collect valid statistics as to the existence of leprosy among the rich and influential, and by the aid more of the doctor than the magistrate, to inculcate, if not enforce, that degree of isolation which the great authorities of Norway deem to be sufficient to combat and resist the danger of contagion. When this has been done, the work of the statesman and legislator will be as complete, very nearly, as they can make it.

Some years must pass before the candid observer in search of truth will be in any position to judge of the value of the coercive action which has now been applied to Her Majesty's Indian Empire, and it will be for a future generation to discover and appraise its full benefit. The writer has no more doubt, not only that the measures which have been taken are wise and beneficent in themselves, but that they are the sure and certain prelude to the final extirpation of leprosy, than he has of the movements of the planets round the sun. He has already had occasion to remark—and he hopes he may be excused for repeating it, and with some pain—that his personal services in the cause have been as completely forgotten as if they had never been; but he believes that the future historian of India will, in the category of India's debt to England, place these measures for dealing with leprosy in the same rank as those by which Suttee and Thuggee were suppressed. But that historian will never know, for those who could have told him will have passed away, that the wise and humane policy by which the most awful of human diseases was conquered and swept away was born, its feasibility proved, and its efficacy established, in a little institution known as the Matoonga Asylum.

DISCUSSION.

The CHAIRMAN said they must all have been deeply interested in this paper. It was quite evident that, after mature consideration, the Government of Bengal and the Supreme Government of India had adopted the recommendations which Mr. Acworth was the first to bring into practice, viz., the segregation of lepers. He had thus very powerfully contributed to the solution of a very difficult problem. On the other hand, all who had heard the paper would recognise that there was a very strong opinion in the opposite direction, and he hoped they would have the advantage of hearing from some of the medical men present an expression of their opinion.

Dr. PHINEAS S. ABRAHAM, M.D. (Ho
Special Committee, National Leprosy Fund),
had listened with great interest to this pap
could testify to the fact that when Mr.
started the Matoonga Asylum his work
ignored, because a notice upon the subject a
in the "Journal of the Leprosy Committee,
publication was still looked upon as one of the
authorities on the subject. It was very cu
notice the apathy in this country and amongst
men and governments of the British colonie
subject. This was illustrated at the Berli
national Conference some time ago, which was
by some scientific men in Berlin, who sent in
to the governments of all the British coloni
conference was attended by 250 delegates from
parts of the world, but he himself was
representative of England, India, or the
Very important investigations were then
forward, and Mr. Acworth's conclusions we
main borne out by the medical authorities
It was very satisfactory to have for the fi
from Mr. Acworth the full history of the M
institution, about which there had bee
confusion, but he could not understand ho
that the authorities had not up to the
time given Mr. Acworth the full credit he
With regard to the etiology of leprosy
question of contagion that was hardly the
place for a discussion; it was a very difficu
tion, and any one who thought the question o
lay in a nutshell and was easily settled simply
that he had not worked much at the subj
regretted to say they did not yet know
poison of leprosy entered the system, but the
impression amongst medical men now was t
was a microbe whose presence could be dem
in well-developed leprous tissues. How that
gained entrance was not yet settled. Mr.
Hutchinson would no doubt explain his vie
was that it entered the body with food; many
that that was possible, but his own belief
the poison might enter in as many ways as t
of tubercle. They knew by observation an
periment on animals that the poison of tuber
gain entrance through the skin, by inoculatio
the lungs, and through the stomach, and he
no *à priori* reason why the leprosy poison m
do the same. But there was this difference
the two, that you could prove these facts wit
to tubercle, but it had not yet been
the case of leprosy, and in spite of Mr. A
observations they could not say that infec
been proved. Although he (Dr. Abraham)
in the bacillary theory he was met wit
facts which he could not get over. Fir
experiments had failed to inoculate lepros
on animals or on human beings. Professo
inoculated 15 or 20 medical students and
with leprosy and not one of them devel
disease. Similar experiments had been

by Danielssen, and in some of the islands recian Archipelago, with the same results. r the attempt at inoculation had been iad failed, except in one possible instance in .. There there was a convict going to be io was pardoned on condition that he sub-) inoculation with leprosy, and a year after- developed the disease, which, at first sight, onclusive; but, unfortunately for the theory, ired that this man's son, his brother, and mbers of his family were lepers, and he came strict where leprosy was prevalent. Know- ey did, how long the incubation period was, is of the disease might have been in his efore he was inoculated. Another fact which chinson laid great stress on was this. There ays a certain number of lepers in England, re the Berlin Conference he (Dr. Abraham) great deal of trouble to get up the d with great difficulty he was able to tween 50 and 60 cases within the last . Of course, there must have been some ho were not traced, and, altogether, there obably have been about 100 cases; but there eason to suppose that there had been any of late years. Ever since there had been so mmunication with India and the colonies been cases of leprosy in England, but, with ption—which might be doubted, though he doubt about it himself—every case in had acquired the disease in India or in one lonies, and it had never appeared on any in- of the United Kingdom who had not been nd lived in a leprous district. In this one ial case, a man came from India with and his brother took it, but that was the e he knew of. If leprosy were as in- as some people imagined, how was it never spread in this country, where no ns were taken against it? Cases were hospitals and treated and attended by doctors and nurses, placed in the same beds, on, as the other patients, there being no at isolation. There were cases now in which he knew personally, many of whom ut just like other people. The public did it, or there might be another scare, such as s some years ago with regard to a case which tioned by H.R.H. the Prince of Wales at ough-house, in which a leper was seen nd selling meat in one of the public markets. orth admitted that absolute segregation was le, as the slighter cases were difficult of , in fact, quite impossible, except by skilled . A child might have a spot on the arm, leprosy might not become obvious to ary observer for many years, but, neverthe- child was a leper. In all leprous countries re numbers of these cases which were not the patients were healthy in other respects, to work, and an attempt at compulsory segregation of such persons would not be tolerated. It could be done in a partial way, as was done in Norway, but it was only partial. He was there in 1888, three years after the compulsory clauses were introduced, and saw cases of leprosy walking about the streets. The doors of the asylum were not locked, the inmates could go out, and the doctor in charge of one institution told him they allowed the inmates to go out and walk about, but did not like them to go to churches or crowded places, otherwise they were practically at liberty. With regard to the isolation in their own homes, which Dr. Hausen laid stress on, they knew it was impossible to insist on people, who were perfectly free, in such a country as Norway, being strictly isolated in every way. At the same time he admitted that this partial isolation had had a very good effect in calling attention to the subject, and also directly in diminishing the disease; and Mr. Acworth had done great service in showing the possibility of doing this in India. But when they saw the riots which ensued when the Government enforced certain sanitary measures in connection with such a malignant disease as plague, it struck him at once how much more trouble there would be if any stringent measures were attempted with regard to leprosy. At the Cape an attempt was made to send all lepers to Robben Island, and the result was that the people hid their lepers, great difficulties arose, there was a danger of riot, and a few years ago it became quite a political question. The compulsory clauses had now been modified, and lepers were allowed to remain in their own homes, with a certain amount of isolation and notification. It seemed to him that was the proper way of dealing with the question. Of course, those who went about begging and showing their sores should be compulsorily isolated, and the others should be isolated as much as possible. In his opinion the Government of India had been wise in passing their Act of 1896, and, he believed, that this could not have been done had not the possibility of carrying out such measures in India been demonstrated by Mr. Acworth.

Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., here took the chair in place of Lord Onslow, who was obliged to leave.

Mr. Jonathan Hutchinson, F.R.C.S., F.R.S., said:—None of us can, I feel sure, fail to give to the author of the important paper which we have just heard, our hearty applause for the humanity of motive and energy of action which it displays. Without doubt, he has set an excellent example and accomplished a very beneficent work. To admit this, and to admit it thankfully and without stint, is still very far from signifying acceptance of his conclusions. Seldom indeed has, I think, a better example of counting chickens before they are hatched been afforded, than that given in some of his latter paragraphs. Mr. Acworth feels confident that he has commenced the

extermination of leprosy from India, but he has not offered us the slightest proof that he has done anything towards diminishing it. What he aimed at doing, was to remove conspicuous lepers from the streets of Bombay, and this he has accomplished partly by straining a legal enactment beyond its scope, but chiefly by bringing into play the living law of kindness. He built a leper house, and made its inmates comfortable and happy, and thus, as he has repeatedly told us, he attracted to it even more than it could accommodate. If, in addition to this, he fenced it with barbed wire, and employed the police to apprehend vagrant lepers found in the streets, it is yet absurd to call his place compulsory isolation in the sense meant by the sanitarians. His measures were, indeed, directed to the concealment of the leper from sight, rather than extirpation of the disease. For the latter object, the leper who lives at home must, according to the theories of the contagionist, be sought out and forcibly removed from those whom his presence endangers. To take into custody those only who obtrude themselves in the public streets, is to crop off a few of the shoots of a shrub, whilst leaving its roots undisturbed. The "segregation" which Mr. Acworth accomplished was kindly and judicious, the measures at which I have hinted are, if not necessary for the public, cruel in the extreme to the individual. I do not believe that they are necessary, nor that however rigidly carried out, they would exercise the slightest influence upon the prevalence of leprosy. They would leave its cause wholly untouched. In saying this, let me say again that what Mr. Acworth did has my approval; I dissent only from his assertions as to what he thinks he was doing. There is no inconsistency in being an advocate for leper-asylums, and, at the same time, a disbeliever in contagion. I am a Christian Socialist enough to hold that it is the duty of the State to provide for the maintenance and comfort of all who by misfortune are disabled from earning their own living, and I see nothing at all unjust in a community declaring that it will not permit loathsome exhibitions of disease in its streets. In these respects the leper, and the victim of any other disabling malady, should be treated alike. In most parts of Mr. Acworth's paper there is a tone of most judicious moderation, and a very evident desire to avoid exaggerations. This is shown in his statements of the number of lepers in India and in Bombay, and in some of his references to the fallacies of statistics. We may thank him for not having attempted to construct any statistics of his own; and if he has been—as I think he has—misled by those sent us from Norway, it is not a matter for surprise. Permit me to say a few words about these, with the object of showing that they do not prove what they are supposed to do. Leprosy at one time prevailed extensively all over Europe, including the British Isles. In the latter it lingered last in the Shetlands. It disappeared from amongst us by slow degrees, *pari passu* with the advance of

agriculture, and it is not more than a ce
the last case occurred in the Shetlands.
period of its decline it attracted but little
and all measures of isolation ceased to b
Now when it died out in our northern isla
lingered on the opposite coast of Norw
Iceland. The parts of Norway in which i
were chiefly those on the west coast, with
Molde for their centres—the homes of
industry, and the homes, in another s
population steeped in poverty and alm
without agricultural land. They had partic
little in the general advance in social com
in more fevoured regions, and they were s
dependent upon fish as food. Yet there i
believe that for long leprosy has been slo
decline in Norway. That it has delined m
in the last fifty years we may thankfu
Norway has become a pleasure-ground f
and wealth and comfort have increased, an
those conditions have prevailed before w
other temperate countries professing the
religion, leprosy has always yielded gr
claim the recent diminution of the diseas
attributable to segregation is to ignore the
of other countries. Leprosy was commo
Zealand during the early period of our c
but with the advance of agriculture and t
tion of fishing it has disappeored, witho
whatever from attempts at segregation. A
gation in Norway, the truth is that it
of very recent introduction, and only
partial extent. The disease was rapidly
before the new law was enacted, and at a
lepers were frequently to be seen in the
Bergen. When the new law was passed,
necessary to provide any additional accon
for what existed was quite enough.
plausibly held that the new law has been m
cident with the decline of the malady
causes, and that to boast of its results is to
fly on the coach-wheel. Mr. Acworth h
that to him it appears the "merest trifling
that the 300,000,000 of India's population
for the extirpation of leprosy, until it is bro
by "the general improvement of physical
and sanitary surroundings." Surely it is no
to remind him that if such improvement
means to that end, he will have to wait.
of nature are inexorable, and we shall do w
them patiently, and not to rush in ignorant
useless expedients. Leprosy has disapp
a thousand of its old-world haunts, and i
so under the influence of precisely those cha
which we are now told it is the "merest t
wait for. I hope soon to show that even i
to them it is not necessary to wait inac
that there are measures which may b
promptly and with great hope of success.
barbarous in the extreme have been th
which in the past have been resorted to

n of leprosy. Permit me to record my —a conviction resulting from a lifelong ıe subject—that those measures have never d in the least to the end desired, and that as meanwhile been slowly brought about by ıfluences which are now spoken of so dis-. I will now try to show that the extirpa- rosy by natural measures—by such, I mean, removing its cause—is not perhaps so hope- ıe have imagined. The data do exist which ıble us to form a confident opinion as to the ts cause, and it is not one which is irreme- of these data, the non-medical mind is well capable of judging as the trained and it is much to be desired that the ublic should look at the facts for itself. loes not require much medical knowledge to the bearing of some of the facts, which I mention. Leprosy is identically the same , Norway, the Sandwich Islands, the East Indies. Inference: that it has nothing to do with race or climate. Leprosy affects s well as the poor, and may develop itself ans who go to live in leprosy districts, and army officer or the missionary precisely the ıse as in the poorest native. Inference: it ressary connection with poverty or personal Leprosy prevails extensively in some places, tance the Sandwich Islands, in which as od clothing and climate, no sort of hardship ı leper asylums, the doctors, nurses, and ever contract the disease. Inference: it is gious. When lepers are imported into where the disease does not prevail as, for in- om Norway into the Unitad States, er communicate the disease to others. : It is not contagious. In further on of the last proposition it may be t no year passes without the introduction ınd of a certain number of lepers (English- ho have developed the disease abroad). In the nature of the malady is carefully con- d they mix with their friends without any recautions. No single instance of any of contagion has occurred. Dr. Abraham ly referred sufficiently to a single case which in Ireland. It is a solitary one, and doubt. I have on the table before me a ı which I have endeavoured to mark the t present the homes of leprosy. The lessons lobe are most instructive, but I must not o speak of them excepting in the most erms. You will find that there are black the seaboard of almost all well-populated . The chief exceptions are parts of Europe, h Islands, and the United States. At many pots marked, however, there are but few ıt more perhaps than might be counted on hands. These few have, in most such had their representatives for many genera- ıd although no segregation, as a rule, is attempted, their number does not increase. I ask does this look like contagion? In many other places, however—Japan, China, the Malay Peninsula, India, Ceylon, the West Indies, parts of South America, the Sandwich Islands—I have been obliged to use the brush very freely. In most of these places, however, although the number is large there is reason to believe that it is either stationary or declining. Were it capable of spreading by contagion we should—since the precautions taken are in most places of the weakest possible kind—expect it to attain universal prevalence. Surely it does not need a medical education in order to see that a disease which affects half-a-dozen people at fifty different places on the shores of the Baltic, another half-a-dozen in New Brunswick, and a few more in Crete, and which never spreads, has far closer analogy with a dietetic disease such as gout than with a contagious one like small-pox. Just as gout prevails in certain districts among certain classes and certain families and does not spread, so it is with leprosy. The legitimate inference is that both are dietetic diseases, and the legitimate hope is that as gout is yielding before tea, coffee, and temperance, so will leprosy yield before the substitution of cereals, potatoes and flesh food for salted fish. Another argument of greater cogency is, I think, fairly obtainable from examination of the leprosy globe now before us, when it is explained that in nearly all the places where the disease prevails now it had done so from time immemorial. It is not the fact that European intercourse introduced leprosy to aboriginal populations, as has been the case with many other maladies. Everywhere we found it there already, and everywhere the same. Go where you will—Japan, China, Borneo, Sumatra, New Zealand, the East and West Indies, everywhere, provided you keep near the coast and amongst races which have learned the art of fishing—and there you will find reason to believe that leprosy has existed from the most ancient times. Quite recently, in the Fiji Islands, "Leprosy Stones" regarded with superstitious reverence have been found in many districts (Dr. Corney). I do not see why it should be held to demand the acumen of a physician to determine the bearing of this remarkable fact. If a disease is found to be one to which the whole human race when residing in certain districts and adopting certain habits has from all times been liable to suffer, and if that disease is found to prevail independently in many countries, islands, as well as continents, which through long ages have had no communication with each other, does it not follow that it is a malady capable, so to speak, of spontaneous origin? Is it not proved almost to demonstration that it cannot owe its origin to contagion, but must rather take its rise in some usage common to the human family? No usage can I affirm be suggested which does not concern an article of food. In this matter I am half inclined to make appeal to the intelligence of the public against the prepossessions of my own profession. I shall be

told by the latter that it is absurd to compare leprosy with gout, because in the one there is a bacillus and in the other none, and that where a bacillus is present the malady can be none other than contagious. The medical mind is at present engrossed by the study of microscopic organisms, and is dazzled by the flood of new light which has dawned upon us repecting them. In a little time we shall see more clearly, and I much mistake if we shall not then come to recognise that these organisms are themselves fed by food, and in many diseases their development denotes only a stage in the causation. To say that because bacilli are present therefore a disease must be contagious and contagious only (whether it be done in case of tuberculosis or of leprosy) is, I cannot but think, to go far beyond what has been proved. Mr. Acworth would possibly call it having regard for logic. I would myself rather say that it is a lapse of logic, since it rushes to an inference before it has been ascertained that the premises are true. The bacillus may be in latent forms ubiquitous, and may take its energy and its special form of development from the food with which it is supplied. There is nothing that I know of that has been proved in reference to the life history of these organisms to disprove such an hypothesis, and very much in its favour. For the present, however, it will probably be caviare to most zealous bacteriologists, and for that reason I venture to hint that intelligent lookers-on are entitled to form their own opinions. That I may, if possible, avoid the risk of being tedious let me hasten to aver my own conclusions. The chief of them is this, that if a malady has been proved to be almost universally prevalent, to pay no regard to climate or to race, to riches or to poverty, and to be at the same time neither hereditary nor for practical purposes contagious, there is but one inference possible, and that is that it must be caused by some article of food. I defy anyone to accept these propositions and to arrive at any other explanation of the facts. My next conclusion is that there is but one article of food which can be plausibly suspected as the cause of leprosy and that is *uncooked fish*. Again, I defy anyone accepting the food hypothesis to mention any other article. Just as we may be quite sure that it is no telluric or climatic influence which causes leprosy, because the disease prevails in districts which vary widely as to these; so we may be sure that is neither flesh of pigs, rancid butter, or any kind of vegetable, for we find leprosy amongst people who vary exceedingly as to their use of all these. On the other hand, as regards uncooked fish, the evidence is *primâ facie* overwhelming. In almost every district where leprosy prevails, fish has been suspected. The disease prevailed in aboriginal communities, and in times when fish was extensively used, it still prevails in large fishing centres and along sea-coasts. Excepting under special conditions, it is unknown in inland districts. One of the most recent writers on the subject (Mr. Ehlers), speaking of its present distribution in Europe, has used the expression, "it forms, roughly speaking, a ring round the cont has disappeared from numberless places sim with the progress of agriculture and the s of other forms of food for fish. It rose in its highest point when the supremacy of t Catholic Church, with its numerous fish f its height (in the time of Hildebrand), and dent with a low state of agriculture. I decline, it is true, before the days of the R but the rate of decline was apparently helped by that event. It still apparen as Europe is concerned, has a great p for Catholic communities. It did not Greek Church into the interior of Russia, not occur there now, for that Church forbic fish as well as of flesh on its fast days. years it has increased largely in the Sandw and at the Cape, and at each place coinci the establishment of a company for salting fish. The fish hypothesis covers well, I facts as to the prevalence of leprosy in all world with the exception of certain distric In many the evidence in its support is indeed. Respecting certain inland distric which suffer, I well know that I shall that fish is not there to be had, and obtainable the religion of the race forbi To this I am able to reply that th which has been given me by those resided in those districts has been most co and that I have been assured by man good right to give opinions, that nowher fish-food inaccessible; that amongst no religious prohibition wholly avail to excl further, that the statements made by n their dietetic habits, are absolutely untrustw fish theory does not imply a large consump but rather the use of it—it may be in quaatities—but in very deleterious form. use I do not believe that any distr race in India is wholly exempt. Furthe added that the degree of prevalence is al in ratio with what is probable in this r Dr. Vandyke Carter, because, as Mr. Acw eulogistically, his practice and his opinio consistent, it has been said that he was of logic and not its slave." I am not not to see that there is something epig this expression, but I am too dull to a force. Most willingly would I be, if I slave of logic, and deeply should I correctness of my opinions if I could n practice upon them. The leprosy questic all others suffered from this masterfu of logical thought. Surely it is not in acc either logic or common sense to go on a the disease spreads by contagion, when th overwhelming in the opposite direction. logical (and if not logical, is it wise?) to act as if the disease were in some direct with poverty and neglect, when it has

:h and cleanly suffer in precisely the same Nor is it logical to go on repeating, and ipport by reference to authorities, statements e been refuted over and over again by o facts. I understand by logic the applica- and reasoning processes to the subject in although it is very certain that nothing hematical demonstration" can be attained h which we are now dealing, yet I feel sure who are weak enough to let their prejudices ssessions override the conclusions derived ireful investigation of facts, will never ie truth. My own theory as regards the eprosy is that it is a malady closely allied losis. Its bacillus is one that can hardly be ed from that of tubercle, and the two uch at more points than one. It might e termed "fish-eaters' tuberculosis," such ig allowed to imply that the bacillus of s in the leper modified by fish-food. dy I would suggest is an inexpensive one, not in any way curtail the food of the com- It would be simply to prevail upon those prosy districts never to partake of partially omposed fish. At the same time, that no ld be spared to diffuse information, and to change of habits in this matter it is very that leper asylums should be founded there are lepers. It should, however, be lerstood that they are for the benefit of the not for the extermination of leprosy. To iat they will have any efficacy in the latter and to base such suggestion on the creed isease spreads by contagion is to proceed on pothesis, and can only lead to disappoint- The true friends of the leper are those who ously seek to discover its cause and to remove nclusion, I have but to repeat what was said tset, that I feel most grateful to the author iper for a most praiseworthy example of benevolence, whilst, at the same time, I ree with him in thinking that the measures tes would produce the results he anticipates. eans, let us have leper homes, but let us much as possible from resort to the police- "barbed wire," and conduct them rather on ple of the farmer who tethers his flock by their Make the homes comfortable and attractive, oor creatures will gladly resort to them. Any n which proposes to deal with leprosy as a is disease and to enforce isolation on that deserves, I must contend, the strenuous n of all who are well informed as to the the subject. On the other hand, legislation e well warranted which should restrain as nfit for human consumption," the fabrica- use of certain articles of fish-food now in India. It would be justified on the it would strike at the real cause of leprosy, the terrible sufferings it produces, and in time altogether with the need for leper homes.

Mr. H. M. Birdwood, C.S.I., said that there were not many present who would refuse their sympathies to Mr. Acworth in the circumstances narrated by him, or would blame him for placing before them the facts relating to the establishment of the Matoonga Asylum, near Bombay, which had been so strangely misapprehended in the Governor-General's Council, on the occasion of the introduction of the Lepers Bill in July, 1896. No one would, of course, think of suggesting that Sir John Woodburn was for a moment aware that he had not correctly realised all the facts of the case, and no one more than himself would regret the mistakes as to matters of fact into which he had been unwittingly led. But none the less must it have been an invidious and unpleasant task for Mr. Acworth to correct those mistakes—seeing how closely his own name and official reputation had been associated with the establishment and success of the asylum—and the thanks of the meeting were due to him for explaining so fully and clearly the history of an institution which had already justified its existence, for it had solved a most difficult problem which had troubled some of the best minds in India, and had made it possible for the Government of India to inaugurate a course of legislation which might prove to be of untold benefit to the people of India. Mr. Acworth was perfectly correct in saying that the Matoonga Asylum was not constructed by the Bombay Government, and that the munificent offer by Sir Dinshaw Manekji Petit of a lakh of rupees for another hospital was never taken advantage of for the Matoonga Asylum, as supposed by Sir John Woodburn. The facts were well known in Bombay, and had indeed been set forth in detail in a valuable Blue-book issued by the Government of India in 1896. From his own personal knowledge, he (Mr. Birdwood) could say that the necessity for remedial action had become apparent about ten years ago, at a time when the increasing wealth of Bombay and the charitable disposition of its citizens had attracted many mendicants, including large numbers of vagrant lepers. The consequent condition of the public streets and thoroughfares was graphically described in a letter from Lady Thompson, which appeared in the *Times of India* in June, 1899, under the signature "A," in terms not very different from those used by Mr. Acworth. The letter was prompted by warm sympathy for the homeless, penniless, and friendless lepers, whose miserable state was in such constant evidence, and also by an earnest desire to protect the public from a threatened danger. The writer pleaded for funds for a temporary home for the sufferers, pending the completion of Sir Dinshaw Petit's proposed asylum, and promised a subscription of Rs. 500 for that object. It was that letter, Mr. Birdwood believed, which set Mr. Acworth on further enquiry. He at once decided that a temporary home must be provided by private enterprise, without waiting for further action from any official body; and with characteristic energy he took immediate steps for forming an influential committee of the foremost citizens of

Bombay, which held its first meeting in Sir Dinshaw's house. His efforts were so far successful that, by May, 1892, the committee had collected nearly Rs. 100,000. But so early as in August, 1890, work was commenced on the requisite buildings from designs prepared by Mr. Rienzi Walton, the executive engineer of the Municipality, and by June, 1891, the buildings were ready for the accommodation of 300 patients. Towards the cost of these buildings no contribution was received from the Government of Bombay, though, at the very outset, an impulse was given to the collection of funds by a prompt personal contribution of Rs. 1,000 from the Governor of Bombay, Lord Harris, who thus showed his interest and sympathy in the movement; and he would have been present at the meeting if his presence had not been necessary elsewhere on important duty. It was undoubtedly a courageous act on Mr. Acworth's part, in the conflicting state of scientific opinion as to the advantages, or even the possibility of segregation, thus to start an institntion in which the segregation of lepers was to be compulsory. He was not indeed without the warrant of strong scientific opinion in support of the action taken by him. He had acknowledged his indebtedness to the guidance of Dr. Vandyke Carter, whose preponderating influence had also been felt in the discussions of the Committee of the National Leprosy Fund. Dr. Bidie, of Madras, was on the same side; and so, among others, were Dr. Stephen, the Sanitary Commissioner of the Panjab, and the Public Health Committee of Calcutta. Dr. Bidie pointed out, in an important contribution to the Blue-book already referred to, that leprosy had appeared in certain countries for the first time only after the arrival of lepers from other countries. Thus leprosy was introduced into Australia by Chinese lepers; into South Africa by Kafirs; into South America by the early Portuguese colonists; into the West India Islands by negroes; into the United States of America by Chinese and Norwegians; and into Canada by Norwegians. In Norway itself the compulsory segregation of lepers had apparently resulted in the reduction of 20 per cent. of the leper population in 20 years; and Dr. Bidie also expressed the opinion that the direct result of restrictive measures in Great Britain was the extinction of leprosy, though that result might also have been due, to some extent, to other causes; improved hygienic conditions, and a higher standard of personal comfort having in time fortified the people against attack. There would then appear to have been some ground for accepting the direct communicability of leprosy as "a good working hypothesis" for a civil administrator, on which to base measures of reform; but Mr. Acworth was the first to put the question to a practical test, under the authority which he held to be given him by a local Municipal Act; and his action had now been endorsed by the Indian Legislature, after a full and careful consideration of the opinion of the Leprosy Commissioners, as recorded in their able report, of the members of the committee of the National Leprosy Fund, and of member[s of an] experienced staff of civil and medical offi[cers in all] parts of India. No doubt this action had [been taken] in view of administrative considerations, [rather than] on strictly medical grounds; but there c[ould be no] question that the inmates of the Matoon[ga Asylum] had benefited in health; and their state wa[s] better now than at any previous time. [It had not] been difficult, except at first, and for a sho[rt time, to] detain the patients within bounds. Even [in his most] anxious moments, Mr. Acworth had nev[er thought] of such stringent measures as had commen[ded them]selves, in a former age, to the authorities o[f the] Asylum at Greenside, near Edinburgh. T[he inmates] of that asylum—as stated in Dr. Bidie'[s report—] were forbidden, on pain of instant death, [to leave it] or even to receive visitors; and a gallows w[as erected] outside the hospital to show that the auth[orities were] in earnest! Mr. Acworth was content w[ith gentler] methods; and had his reward in witnessin[g the com]plete success of his plans for the "purgati[on" of the] City of Bombay, and in the knowledg[e that the] unfortunate lepers, whose welfare he ha[d at heart,] were in the enjoyment of comforts to whic[h they had] all their lives, till then, been strangers. [The legis]lative measures adopted hitherto were n[...] extreme caution; but that was only rig[ht in the] present state of our knowledge of lep[rosy. He] (Mr. Birdwood) hoped that the time wo[uld come] when leper farms, which had been st[rongly re]commended by competent advisers, would [be estab]lished in selected districts throughout India [...] suffering from black leprosy, ought to be [...] from large towns. Employment on agric[ulture and] horticulture could not fail to improve the[ir] health, and to cheer their last years, so [far as it] was possible. Leper farms were said [to have] succeeded in Cyprus and elsewhere; and it [was satis]factory to know that the question of their [establish]ment in India had been engaging the attent[ion of] Government. But whatever further meas[ures might] be developed, Mr. Acworth should be as[sured that] the good work done by him in Bombay [would not] soon be forgotten. He was one of a suc[cession of] Administrative officers, drawn from the ra[nks of the] Indian Civil Service, who had filled wit[h] success the position of Municipal Commi[ssioner of] Bombay, and had helped to bring the Muni[cipality to] the forefront of municipal institutions in Bo[mbay...] Acworth would certainly, in reference to [the] work done by him in Bombay, be the first t[o] the proud boast that, among the servants of [...] of all grades and departments in British In[dia], were "five hundred good as he." Still t[o him had] fallen the privilege of accomplishing a spe[cial work] of beneficence, the value of which coul[d not be] estimated too highly. It was as fine work a[s] had been done in the last ten years, signalis[ed as] some of these years had been by noble eff[orts in the] contest with famine and pestilence. He ([Mr. Bird]wood) was glad to be there to testify to the [...]

ENDISH BOYLE, K.C.M.G. (Government British Guiana), said he was not there as a alist or as an experienced officer of the Indian ce, but merely as a humble representative nies. The more he heard of this great sub- he more he saw of it, the more certain he w to deal with it was a question at present power of any man to decide, whether he nber of the Royal College of Surgeons or erial Institute. He was quite sure they had t to the bottom of it, and he feared they for a long while to come. His experience in connection with some of the West Indian nd more recently with the colony of British here there were not only negroes, Portu- Chinese, but a considerable number of hough that colony was larger than the whole itish Isles, it had a population of only f whom more than a third, 108,000, n coolies. During 1897-8 they dealt with ; of course, there were many more, but were isolated, being nearly 2 per 1,000 pulation. What would be thought in there were a similar proportion of lepers in tion of 4,500,000; and if provision had to be ospitals or asylums for 9,000 leper patients? hought they would look at things somewhat He did not suppose that many present v what a terrible scourge leprosy was, and tely necessary it was to do all they could bad cases mixing freely with the ordinary . They had heard something about the ing completely hidden, and that there few lepers in England whom no one ; but what was to be done with a poor ho could scarcely be called a human being, so horribly afflicted by the disease that you hide him? Either you must lock him up in a t everyone who came near him know what uffering from. He had not seen such England, but he had seen hundreds of e Colonies. He could not say anything on oversy whether segregation would stop it or isolation of these poor people in asylums, y would be looked after and attended to as d not be elsewhere, and where the rest of rable lives would be led as easily as possible, essential in every colonial government. ham had referred to the apathy of the with regard to the Berlin Conference, could assure him that the only reason colony was not represented was lack of What he had heard that day, and what he from the medical staff in the colony, how- him to the conviction that if the members of rence came back with honour they did not k with peace, so far as controversy was l. for they did not seem to have decided right and who was wrong. He would say, sion, that coming from a colony where people from almost every country in the world, the Government of which was as benign and considerate as possible, when lepers were found exposing themselves to the detriment of the community, it had been thought necessary to isolate them, and he hoped that would continue.

The CHAIRMAN proposed a cordial vote of thanks to Mr. Acworth.

The vote of thanks having been carried unanimously,

Mr. ACWORTH, in reply, said that he wished to reiterate, in reference to the remarks of Dr. Phineas Abraham and Mr. Jonathan Hutchinson, that he was not an advocate of the theory of contagion. He had no theory of his own as to the origin of leprosy; but he thought that the right measures for dealing with it were those which would be adopted if that theory was the true one. He must repel the imputation that he was disposed to scoff at sanitary science. On the contrary, he had been an apostle of it in Bombay for years. But when he was told, as by the College of Physicians in 1862, that it was the duty of the Indian authorities to sit with folded hands in the presence of an intolerable pest, philosophically waiting until, in the lapse of centuries, sanitary science had remoulded the habits of 300,000,000 of people, then he said and he maintained that this was to trifle with the question in the name of sanitary science. Dr. V. Carter had, in effect, said the same thing. His eulogy of Dr. Carter as the master of logic and not its slave had been condemned, but yet the idea conveyed was a trite one. What he meant to say was that that great physician was able to survey the question with the eye of a statesman, as well as with the eye of a doctor; that he was able to realise that human affairs are not governed by pure reason; that impulse, passion, prejudice, sentiment, imagination, have to be taken into account, conditions of the mind which are not governed by logic. Our system of government in India was an utterly indefensible one on logical grounds, but was there anyone in that room who doubted its excellence? Mr. Acworth concluded by expressing his acknowledgments to the Earl of Onslow for taking the chair on that occasion, and to Dr. Abraham, Mr. Hutchinson, and the other eminent men who had done him the honour to think his paper worthy of discussion. However much they might disagree with him, he was not the less grateful to them for their presence.

Professor W. J. SIMPSON, M.D., writes:—I wish to add my testimony to the splendid work done by Mr. Acworth. I took a special interest in leprosy in India, and I well remember that it was due to his influence and energy that a magnificent leper asylum was established on the outskirts of Bombay, that powers were put in force for the compulsory segregation of wandering and vagrant lepers, and that the streets and markets of the city were cleared of a loathsome

and dangerous nuisance. I am accordingly surprised to hear to-day from the paper read that the Bill of 1896 should have been introduced by such a speech as has been mentioned, and that no credit was given to Mr. Acworth, the Municipal Commissioner of Bombay. I did not notice it at the time. I had the advantage of going over the Matoonga Asylum when the arrangements were completed and in full working order, and I had no difficulty in concluding that perhaps, with the exception of the excellent leper asylum near Colombo, in Ceylon, it was the finest in the East, and that everything was done to ameliorate the hard lot of the lepers, and make their lives as comfortable as possible. Thoroughly in sympathy with those who hold the views that leprosy in the towns of India can only be efficiently dealt with by compulsory segregation, I was anxious to see erected on the outskirts of Calcutta a leper asylum established on similar lines to those of Bombay and Ceylon. But progress in some things is slower in the capital of the Indian Empire than in the first city of India, and it took several years to get the first important point decided, and this only after a special note was addressed by me to the Bengal Government in 1893, on the subject that compulsory segregation was absolutely necessary in any new asylum that might be built for Calcutta, and it took several years more to decide on a suitable site. Before my departure from Calcutta plans for the new asylum had been begun, but I fear plague in India has distracted attention from the leper, for I have not heard of the buildings having been completed. There was an old asylum in Calcutta, which admirably illustrated the disadvantages and evils of an asylum near dwelling-houses, and worked on the voluntary system. The asylum was in one of the best residential quarters of the native town, and was the source of frequent complaints from the neighbours, who were subjected to much annoyance by the constant passing to and fro of the lepers; but this grievance was small compared with the fact that the lepers' sores attracted to the asylum a plague of flies, which used to invade the neighbouring houses and alight on the food. The voluntary system, moreover, was of no practical use for the purposes of detention. The lepers would be put into the asylum one day and would be out the next, and the majority used the asylum only as a shelter for the night. With this voluntary system, the same results were to be seen in Calcutta as in Bombay before the compulsory system was introduced. The streets, markets, bazaars, doors of the rich men during feasts, marriages and festivals, and the approaches and entrances to the principal temples were thronged with lepers; wherever begging and the soliciting of alms could be profitably carried on there would the lepers gather exhibiting their hideous deformities with the object of exciting pity. Alms were given to them partly from pity but mainly through fear of the leper coming too near, for the natives of India, notwithstanding any views held to the con-

trary in this country, have a wholeson
the leper and of his disease. I h
been opposed to voluntary segregatio
however advantageous it may be in
breaks down in practice. The Leprosy C
in advocating voluntary isolation, had n
experience of the subject; and, after a car
of their report, I have, like Mr. Acworth, b
to understand on what grounds they recom
because they came to the conclusion that l
not hereditary nor contagious, but arose *d*
that the virus was widely distributed thro
I attribute this extraordinary conclusion,
contrary to the experiences of all those
given special attention to the subject
countries, to the fact that the Commission
too much in the limited time at their dis
instead of visiting the whole of India, and
different parts 2,500 lepers, out of a reput
of 105,000, or less than 3 per cent., they
and studied the disease in some of the wo
parts of the country, I believe they would
to a different conclusion. One of the Co
visited Burdwan, which is one of the wors
remained two days, and saw 23 cases out
less than ½ per cent. Chamba, which, a
the last census, contained 20 to 30 lepers
was not visited at all. Attention should
concentrated on such places as Ellich
leprous population increased in twenty
5 to 16 per 1,000; Goalpara, which incr
7 to 19 per 1,000; Manbhum, which inc
5 to 12 per 1,000; and Pooree, which inc
3 to 15 per 1,000. This increase is very
if it be remembered that the life of a l
nine to twelve years, and that, conseque
years, 70 or 80 per cent. of these would di
therefore, a maintenance of the average
fresh supply of lepers equal to that rate,
place of those removed by death; while a
in the ratio indicates a much larger pr
increase of the disease, and this is intensi
fact that the birth-rate among lepers is
low. Notwithstanding Dr. Abraham's v
inclined to think that all that is positi
regarding leprosy is against the conclusi
Commission. Dr. Vandyke Carter, in
showed that out of 1,564 lepers, into w
history he had made inquiries, 64 had a
in the direct line, that is in father, mother
parents; over 14 per cent. in the collatera
is among the uncles and aunts; and 21
the co-equal line, *i.e.*, among brothers
This positive information in no way favou
that the virus is widely scattered through
the contrary, it indicates that the virus ha
of a very marked character, and has a ve
relationship with family life. This invest
made before Hansen's discovery of t
bacillus, and before the relative *rôle* and
which heredity and communicability p

f leprosy, was differentiated. It is now conceded that heredity does not play a very t part in the production of the disease, and, ese circumstances, the facts brought out by Carter, as to family disposition, points to cability by close and sustained intercourse. v is supported by facts in another direction. l over again instances have occurred of a ning to live in a village or house where there eprosy, and sooner or later forming a focus or infection to the villagers and members of ehold. As it has been stated that no case of on of the disease has been experimentally I will mention one accidental experiment, ows that the disease is inoculable. It is a orded by Dr. Tache, of New Brunswick, in which a young man was inoculated from of a woman whom he helped to carry to her "The day was hot, and, on a sudden, liquid began to ooze out through a joint of the etting the shoulders of one of the carriers. combined with the heat and the pressure of p edge, produced an abrasion of the skin of ng man. The contact of the liquid with the surface lasted a part of the time of the pro- and the whole length of the service, as only on his way home that the young shed his sore shoulder and changed his Some months after, that man, whose had always been robust, began to feel In a short time the symptoms of leprosy eir appearance, and he died of the disease ears after the occurrence. There had not case of leprosy in the family, whose ancestral y is traced for several generations back; in disease was not yet known as leprosy, being t appearance in the locality and among those He was the fourth case in that place, the ners being the woman spoken of, the husband er of the woman, in the ancestry of whom d never been any trace of the disease; the e in that locality was the sister of the young Both Chinese and Indians believe in the icability of leprosy, and this is no new doc- h them. It was held years ago in India at a igh civilisation and enlightenment. Susruta, t Indian physician, sums up the observations me, which are just as applicable to-day as re then, as follows:—(1) "Women and men heir blood and seminal fluids corrupted from (not of the white kind) get their offspring (2) "The diseases named below are trans- from one person to another by sexual rse, by touch, by taking meals in the sh, by sleeping in the same bed and sitting same seat, by putting on the same gar- by wearing the same garlands, and by using ne ointment—leprosy, fever, consumption, nia, and small-pox of different kinds." A been expressed that compulsory segregation roduce rioting similar to that which happened when plague patients were segregated. This apprehension is based on a misapprehension of the nature of the two diseases, and the point of view from which they are looked at by the people in general. Segregation of lepers is on a totally different footing with segregation of plague patients. Leprosy is a chronic disease, loathsome in its nature, and a general object of dread. The family, as a rule, soon get tired of the patient and are glad to get rid of the lepers—in fact, he or she as often as not becomes a wandering outcast. Plague is an acute and very fatal disease; its effects are sudden, and the patient is removed to hospital at a time when the emotions of grief are most acute, and the friends are swayed by their feelings. As so many who are taken to hospital die, it appears to the Indian mind, as it would to the poorer classes of other countries, that there is a direct connection between segregating their relations in a hospital and their death, and it is easy to understand in their excited frame of mind the revolt against segregation of plague patients. No such fears need be entertained regarding the segregation of lepers; and if the lepers are treated kindly in the asylums, and everything done for their comfort, remembering they are there, not as prisoners, but as unfortunates for whom every care should be taken, I believe compulsory segregation will do much good, especially, if after the removal of the leper to the asylum, the house in which the leper lived is thoroughly disinfected, or, if a hut, is burnt down.

Obituary.

JEREMIAH HEAD.—Mr. Head, the eminent consulting engineer, died at Hastings on the 10th inst., at the age of 64. He was articled to the celebrated Robert Stephenson, and early took a prominent position as a mechanical engineer. In 1865 he inaugurated the Cleveland Institution of Engineers. He built the Newport Rolling Mills, and from 1867 to 1874 these works were carried out on the industrial co-partnership principle. He was one of the original members of the Iron and Steel Institute, and in 1875 was elected a member of the Institution of Civil Engineers. In 1885 and 1886 he was President of the Institution of Mechanical Engineers. He read papers on Iron Ores and Manganese Ores before the Iron and Steel Institute, and last month he read a paper before the Institution of Civil Engineers on the Iron Deposits of Lake Superior. Mr. Head was elected a member of the Society of Arts in 1873.

G. W. LEITNER, LL.D. — The distinguished Orientalist, Dr. Gottlieb Wilhelm Leitner, died from pneumonia at Bonn, on the 22nd inst. He was born at Pest, on October 14, 1840, and at the early age of fifteen was appointed (1855) first-class

interpreter to the British Commissariat during the Russian War, with the rank of full colonel. In 1866, Dr. Leitner made a special investigation of the languages and races of Dardistan. In 1874, he read a paper before the Indian Section of the Society of Arts entitled, "Account of the Races of Dardistan." In the following year he was elected an honorary corresponding member of the Society. He was for many years Principal of the Lahore Government College, with which the Delhi College was incorporated, and he was the first Registrar of the Punjab University. In May, 1884, he read before the Indian Section a paper entitled, "Thoughts Suggested by the Past and Present Condition of Indigenous Education in India." Besides these papers, he was a frequent contributor to the *Journal*, and a constant attendant at the meetings when papers were read which dealt with subjects connected with the scenes of his travels and his special studies. On leaving India he settled in England, and founded the Oriental Institute at Woking. He was a voluminous author, and for some years edited the *Asiatic Quarterly Review*.

Notes on Books.

THE LONDON WATER SUPPLY. By Arthur Shadwell, M.B. London: Longmans, Green and Co. 1899.

The aim of Mr. Shadwell's book is to vindicate the claims of the Thames as a sufficient source of supply for London for many years to come, and consequently to show that no reason exists for the promotion of a scheme for obtaining a supply of water for London from Wales. It is therefore, to a large extent, avowedly polemic, but it gives a very clear statement of the present condition of the question, and may be usefully studied by those who desire information about it.

It comprises a brief history of the origin and development of the water supply of London, a full account of the present supply, a consideration of the difficulties which arose last year in consequence of the drought, and the partial failure of water supply in East London, and a full discussion of the two schemes for extending London water supply—one advocated by the London County Council, and involving the provision of water from the Welsh mountains; the other proposed by the water companies, and involving the construction of large additional reservoirs near Staines, for the storage of Thames water.

Although, as above mentioned, the whole book is avowedly the work of an advocate, and the statements must be looked upon as *ex parte*, there are some points which are very clearly enforced—prominent among these is the excellence of the present water supply of London (and it would be wel who have not paid any special attention to t facts, would convince themselves of this po another is the sufficiency of the Thames as a supply for very many years to come under all conditions of the increase of population.

THE WATER SUPPLY OF SUSSEX. By Whitaker, F.R.S., and Clement Rei

This is the first of a series of publications Geological Survey propose to publish on t supply of the English counties, and in th by Sir Archibald Geikie, the Director-G request is made that all those possessed information, such as details of the strat through in sinking wells, would forward formation to the Geological Survey Office view of its being used in future issues. portion of the pamphlet gives an outlin geology of Sussex—so far as it relates supply—the rest is principally an account o sections in the county.

MEETINGS OF THE SOCIE

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

APRIL 12.—"Telephones." By JOHN W. H. PREECE, C.B., F.R.S., will preside.

APRIL 19.—"London's Water Suppl WALTER HUNTER, M.Inst.C.E.

APRIL 26.—"Coal Supplies." By T. BROWN.

MAY 3.—"Wireless Telegraphy." By PREECE, C.B., F.R.S.

MAY 10.—"Fruit Growing in Kent." By BUNYARD.

MAY 17.—"Trade Marks." By J. E. JACKSON.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock

APRIL 27.—"Judicial Reform in Egypt." JOHN SCOTT, K.C.M.G., D.C.L., Deput Advocate-General, and late Judicial A H.H. The Khedive. The LORD CHIEF OF ENGLAND, G.C.M.G., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

APRIL 18.—"Inlaying." By STEPHEN

Mr. Lock's paper on "Domestic Fur announced for this evening has been ably postponed.

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FRIDAY, APRIL 7, 1899.

mmunications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

roceedings of the Society.

EIGN & COLONIAL SECTION.

sday afternoon, March 21, 1897; J. M. LEAN, M.P., in the chair.

e paper read was—

COMMERCIAL DEVELOPMENT OF GERMANY.

By C. Rozenraad, F.S.S.

a time when the commercial struggle of ations is more acute than ever, when each ry is striving to secure the largest possible of the world's trade, it is of the highest tance that England should follow intently her rivals and competitors are doing; for ugh Great Britain, with her extensive n and colonial trade and navigation, her rganised monetary and banking systems, ll marching at the head of the great ercial nations of the globe, other nations ot idle; indeed, some of them have made ellous progress in every direction. This pecially the case with Germany, which, s to the zeal, energy, knowledge, and ughness of her business men, occupies an rtant place in the world's trade, forcing England a continual struggle everywhere. d, it is not too much to say that Germany become one of England's greatest comial rivals.

s not the first time that the Germans have a leading part in commerce. Already, Middle Ages, German commerce manil its strength, not only in Germany itself, lso in foreign countries, where the big trial cities of Germany had created comial offices or Hanses, who had obtained, the Sovereign or Government where they constituted, numerous privileges. At these German Hanses were in direct and y exclusive relations with the towns which created them, but, little by little, they joined into one confederacy, forming a defensive and offensive league for the maintenance of peace, the administration of justice, the extension of trade, the regulation of questions of customs and the rate of exchange, representing, in a word, a powerful body. This Hanseatic League owed its origin to the imperfection of the political and social institutions of Germany in the Middle Ages and to the insecurity of trade and navigation in Northern Europe. As international relations gradually improved and Europe attained a higher degree of civilisation, the utility of such a confederacy was less felt, and after four centuries of fluctuating prosperity, after having exercised a considerable influence on the commerce of Europe, they could no longer compete either with Holland, which had succeeded in attracting a large share of their business, or with England, which then had already secured a position of great importance, and had permanently become one of the principal commercial nations. The League was, therefore, dissolved in 1641. The history of the Hanses and that of the powerful Hansa towns, Hamburg, Bremen, Lübeck, and other cities, is one of the most interesting pages of the history of the commerce of the world, showing that, even in those days, the German merchants were already men of energy, of enterprising spirit, and endowed with great business capacity; but the same history shows also that already at that time there existed in Germany a party strongly in favour of Protectionism; that, as in the present day, there were then numerous adherents to commercial restrictions, and absolutism in economical doctrines, the application of which paralysed the development of international commerce, and often gave rise to rivalry between the various German States and towns.

So that, suffering as they did from want of united action, none of the German States or commercial towns ever succeeded in recovering their former brilliant position, and it is only since 1871, when the battle of Sedan ended the dominating position of France in Europe and opened the way for the federation of the different German States into one Empire, that Germany has come again to the front, in a marked manner.

Then the great German who was placed at the head of the affairs of his country showed clearly by his entire policy, that the mainspring of his actions was not only to make Germany strong and powerful, but also to secure for her an important portion

of the world's trade. After having provided a constitution for the United German Empire, to the whole of which he applied the Zollverein, he enforced universal conscription, placed the railways in the hands of the Government, introduced uniform weights, measures, and coins for the whole of Germany. In a word, Otto von Bismarck laid the foundation of the future great German Empire, and, by his wise measures, enabled Germany to compete on the field of international commerce.

Realising that gold is the precious metal, *par excellence*, in the settlement of all international transactions, that England with her gold standard and sound banking policy had become the principal gold and money market of the world, Bismarck created and accepted the presidency of the Imperial Bank of Germany, after having replaced the gulden, banco-mark, thaler and louis d'or thaler, by the reichsmark. He saw how England, by establishing numerous banks and branches in her colonies and in Africa, Asia, China, South and North America, had secured greater facilities for her trade, how bills on England and English acceptances were everywhere readily taken, so he induced his countrymen to establish German banking institutions in foreign parts, especially in countries beyond the sea, to make the German reichsmark and German bills of exchange familiar everywhere, and to secure to the German banks the commission, interest, and profit arising from exchange operations, hitherto paid to English banks, with the result that German banks are founded in the Argentine Republic, Brazil, Chili, and other countries. It had likewise not escaped the great Chancellor, that a well-organised consular corps can contribute materially to enlighten and to extend national trade, and under his able directions, and under those of his coadjutors, an elite class of men was formed, who, abroad, zealously promote the interests of Germany. Bismarck saw that in England and France, the *haute finance* always supports the Government in all that is necessary to advance the welfare and prosperity of the country; so he secured the counsel and advice of the leading bankers of Germany, especially that of the Berlin agent of the first banking house in the world. He observed how the great statesmen in England and France always valued the co-operation of capable men, and so he consulted the first German authority on monetary matters, Ludwig Bamberger, although the latter became his political opponent; he obtained the support of Delbruck, whose knowledge was invaluable in questions of trea commerce; of Stephan, who, in 1874, c the first postal union of the world, and Germany an almost perfect postal and graph service. Bismarck realised the of the numerous steam lines which c England with all parts of the world, so couraged the construction of German boats, obtained subsidies for German s ship companies to all parts of the globe, ships soon vied with English steamers in fort, discipline, and speed. Last, b least, he recognised that free trade w foundation of England's wealth and pros and the Iron Chancellor became a Free-t and succeeded in abolishing all import with the exception of a few fiscal ch And Europe looks full of admiratio German people with feelings of gratitu the man whose indomitable will enable to carry out his schemes for the firm est ment of the greatness of Germany.

Just as under the strong governm Richelieu, Mazarin, and Colbert, prospered; just as under Oliver Cr England had a period of great pros just as under the sway of Napoleon I commerce and industry of France wer flourishing state; so under Bismarck's Berlin became one of the principal fi centres of the world, showing agai business prospers in a country ruled strong political government. Under th hand which had unified and ma Germany, German trade and industry loped in all directions.

But the Germans were carried away b great prosperity. Intoxicated by their re success, led away by the French war co tion of five milliards of francs, they f numerous companies and industrial takings lacking a solid basis; and, usually the case in times of great expan trade and industry, overproduction and trading provoked in Germany, first, a decline in prices, and, finally, a severe This was but a repetition of what occu England in 1847, 1857, and 1866, when, to the disastrous results of overtradin Government was compelled to suspe Bank Act.

And Germany began to look for a remedies. Industry, always prone to tion, asserted itself; it demanded import not so much as a measure of protection foreign competition, because Germany occupied an important position in in

irs, but in order to enforce higher prices, when the German markets were flooded American and Russian wheat, Bismarck to yield to the representatives of industry agriculture, who insisted upon Protection- and the days of free trade in Germany over. In 1879, the first protectionist tariff adopted; the imports of foreign iron, d, and grain were checked, and both nburg and Bremen, hitherto free ports, lly entered the German Zollverein. It soon ime manifest, however, that, as is always case wherever Protectionism is applied, one in the tariff is never sufficient; others are to follow. The industrial tariff was in- sed between 1881 and 1883, and the import on corn was raised successively in 1883 1887.

ow, the history of commerce teaches us Protectionism always fetters interna- al trade, always leads to retaliation, and ory repeated itself again in this case. The -increasing duty on grain had the effect of king, if not of stopping altogether, the rt to Germany of the principal article of sian production—wheat. And so Russia liated by imposing a heavy import duty Germany's principal articles of produc- —iron and steel.

nd gradually the relations between the great Powers became less friendly. The f war was followed by the expulsion by the nan Government of the Poles, who worked he factories and harbours near the frontiers. sia retaliated by imposing regulations ing to restrict the rights of foreigners to l property in Russia. In a word, the ggle between the two great Northern Powers ime fiercer and fiercer, till the German ernment attempted a great *coup* to ermine the credit of the enemy, and, by ee of November 10th, 1887, the Imperial k of Germany declined to make any further inces on Russian securities. From a al, and from a political standpoint, the ificance of the decree was of the highest ortance. For it must not be forgotten that ce Bismarck was not only Imperial ncellor, but also President of the Imperial k of Germany, and the refusal to advance ey on the securities of a country with h Germany still continued to be, officially, iendly terms, could certainly not have been oted without his knowledge, or without his e consent.

nall causes sometimes have great results. introduction of Protectionism in Germany gave rise to the tariff war, afterwards to the financial war with Russia, which, in its turn, led to the political and financial alliance between Russia and France—an alliance which, to a great extent, helped Russia to place her finances and her monetary system on a sounder basis, and enabled her to become a dominating Power, not only on the Continent, but also in Central Asia, and to follow in the Far East, the policy with which we are all acquainted.

As you see, Protectionism has been the main cause of important international events, the consequences of which cannot be foreseen even at this juncture; whilst in Germany itself the further development of Protectionism went hand-in-hand with the progress of Socialism. In vain, did the Government propose measures for promoting the welfare of the working man and the improvement of his lot. Gradually, the situation became more and more critical, and although Bismarck succeeded in maintaining his prestige as regards foreign politics, his domestic policy did not meet with the same appreciation as formerly, either from Crown or from Nation. His fall became merely a question of days, of hours, till at last the faithful servant of Monarch and Fatherland had to disappear from the political arena. He may have committed many errors, but to him belongs the honour of having laid the foundation of the present mighty German Empire as a political and commercial nation.

The work of the greatest statesman of our century was continued by his successor, Caprivi, but under much more moderate commercial and fiscal conditions. The political alliance with Austria and Italy concluded by Bismarck made it possible for his successor to complete it by a commercial alliance with both countries. On the 6th December, 1891, a commercial treaty, based upon lower tariffs, was concluded between Germany and Austria. It was followed on February 1st, 1892, by similar treaties with Italy, Switzerland, Belgium, and Servia, whilst a treaty of commerce and navigation was entered into with Roumania on the 1st January, 1894. These treaties may not be the ideal of what commercial treaties should be, but nevertheless they prove that an end has been put to the sharp protectionist policy followed hitherto by Germany, that more moderate ideas have gained the upper hand there. These treaties being concluded for a term of twelve years will safeguard trade against further tariff variations, at least for that period.

But it was not only with allies and friendly

nations that Caprivi concluded commercial treaties. He did so even with Germany's antagonist, Russia. On the 8th March, 1894, he entered into a commercial treaty with the Government of the Tsar, thereby putting an end to the tariff war with Russia, cancelling also the decree of the Imperial Bank of Germany of the 10th November, 1887, which prohibited advances on Russian securities. So that a more moderate commercial policy healed the wounds inflicted by extreme Protectionism, the amicable relations between the two great Northern Empires were restored, and Berlin once again participated, in a marked manner, in the important Russian financial operations, connected with the abolition of the forced currency in that country.

And the favourable results which have followed the more moderate commercial policy inaugurated by Germany, became more evident. Her influence and commerce developed in all directions. In industry, she became a power; in chemical and electric industries, the Germans are gradually taking the lead. German banks abroad (the Brazilian Bank for Germany, with a capital of 10,000,000 marks, is represented in Rio de Janeiro, San Paolo, Santos, &c.; the Deutsche Ubersee Bank, with a capital of 20,000,000 marks, has offices in Buenos Ayres, Valparaiso, &c.; the Bank of Chili and Germany, with a capital of 10,000,000 marks, is also established in Valparaiso; whilst the German Asiatic Bank, with a capital of 15,000,000 marks, is represented in Shanghai, Tientsin, and Calcutta) contribute, with success, to the promotion of German trade abroad, earning satisfactory dividends for their shareholders.

In Italy, immediately after the disastrous crisis in 1893, which caused 44 banks and banking-houses to suspend payment, the German *haute banque*, together with their friends in Austria and Switzerland, founded two banking institutions—in Milan, the Banca Commerciale; in Genoa, the Credito Italiano, both of which render important services to Italian trade and industry.

Germany, however, is not only represented abroad by banks, but also by her surplus population, which is increasing by nearly 1 per cent. every year. The total population now exceeds 54,000,000, as against 42,500,000 in 1874. Germany sends her sons, fully equipped with the knowledge of foreign languages, to all parts of the world, some as clerks and commercial travellers, others as technical officials and engineers, endeavouring to create new markets and to develop trade between the Fatherland and foreign countries. Everywhere we find Germans and German houses, while German capital is invested in many foreign enterprises. The Keneh Assian Railway was built entirely with German capital, whilst Germany is largely interested in the Netherland South African Railway Company, in the Brazilian Railway Oeste de Minas, and others. Germany is besides busily engaged in Turkey, covering that country with a network of railways. In Russia, Germany has found a large field for her energies, especially in connection with the building of the Siberian Railway, which, when completed, will shorten the voyage for both passengers and goods from Western Europe to China and Japan, and, as the new route traverses Germany from one end to the other, the German railways will reap increased receipts from passengers and goods, without even counting the very important mail traffic between England and the Far East, which now goes *viâ* the Suez Canal, and which, by the new route, *viâ* Germany, will also yield considerable advantages to that empire.

According to official figures, nearly 140,000,000 marks of German capital are engaged in Guatemala, of which half is in plantations; in Mexico, nearly 400,000,000; in Venezuela, nearly 200,000,000; in Brazil, nearly 650,000,000, of which the greater part has been invested in industrial and land enterprises; in Chili, the German capital employed is estimated at 28,000,000, chiefly invested in saltpetre mines; in Africa, 100,000,000 marks. These investments represent more than 1,500,000,000 of marks, whilst the total amount of German capital employed in foreign stocks is estimated at many millions more.

But the great development of trade and industry, the great progress in every domain, and especially the importance the Berlin Bourse has attained as an international market, were a thorn in the side of the Agrarian party, which succeeded in getting a law passed by which Stock Exchange transactions and time-bargains were hampered, in many cases rendered impossible, and by this the German grain market was disorganised.

Whereas commerce in England is regarded as the greatest of all political interests, in Germany the reactionary party attempted to impede as much as possible the further extension of speculative transactions, of commerce, and of industry.

But the German Agrarians have been foiled,

ior Bourse, commerce, and industry combined energetically to oppose such a short-sighted policy. and the very obstacles they experience spur them on to greater activity. The aim of Germany to acquire a large portion of the world's trade remained the same.

The statistics of recent years prove how active German trade and industry have been. From 1872 to 1897 the trade increased 60 per cent., and 30 per cent. between 1881 and 1897. The larger part of this increase is due to the shipping trade, being about 65 per cent. of the total.

In 1898 the commercial advance, far from being reduced, has increased in large proportions. This development will be seen from the following figures :—

Year.	In tons.	In 1,000 marks.
IMPORTS.		
1894	32,022,502	4,285,333
1895	32,536,976	4,246,111
1896	36,410,257	4,557,951
1897	40,162,317	4,864,644
1898	42,718,075	5,477,648
EXPORTS.		
1894	22,833,715	3,051,480
1895	23,829,658	3,424,076
1896	25,719,876	3,753,822
1897	28,019,949	3,786,241
1898	30,086,228	4,001,746

)r less imports and exports of gold and silver:—

	IMPORTS. In 1,000 marks.	EXPORTS. In 1,000 marks.
1896	4,307,163	3,525,130
1897	4,680,697	3,634,975
1898	5,118,529	3,746,628

Compared with other countries, Germany as indeed made great progress, as will be een by the figures in Table I., p. 448.

This development is all the more remarkable s Germany had, like many other nations, to truggle against the Protectionist system pplied by several countries. It is partly ue to the many export unions (*Ausführ-ereine*), whose principal object is to promote reign trade. Especially the Export Union f Saxony is to be mentioned. Established in [ay, 1885, with only 200 members, paying an nnual subscription of 20 marks each, that nion has now thousands of members sending ut travelling commissions, circulars in five nguages, spending between 1886 and 1895 ,000 marks to investigate trade prospects Venezuela, Ecuador, Peru, Bolivia, Chili, exico, Canada, Cuba, &c. In Berlin many rporations and newspapers are working in e same direction, for instance to quote only few:—The Centralverein, for commercial geography and promotion of foreign trade; the Deutsche Colonialverein, with 250 agents in London, Antwerp, and other important commercial markets. In a word, by constant efforts, by continued study and investigation, Germany endeavours to extend her trade in every respect. The commercial struggle between the nations is now so acute, that the efforts of one single firm are not sufficient, they all work together, publishing illustrated almanacs, giving every detail of home products, the addresses of the firms who export them, and readily complying with the requirements of the foreign customers, whether in quality or mode of packing the goods, selling not in marks, but in the currency of the customer, trying in every way to please the client and to facilitate the buying of German goods.

But all these efforts would probably not have had the great results shown by the constant increase in Germany's exports mentioned before, had German commerce not found in Hamburg a most suitable place for the concentration of the export trade. The old Hanse town, with her international trade established centuries ago, with her branches and agents in every country, with her extensive shipping business, is really the principal commercial German town, the principal German market, and no efforts are spared by the Hamburg merchants to maintain that position. Since joining the Zollverein, Hamburg has not only spent more than 300,000,000 marks on improvements in the harbour, but the steam lines connecting that port with all parts of the globe, are constantly increasing, with the result that Hamburg is now the first port on the Continent, ranking immediately after London. The shipping trade of that port for 1898, compared with the three former years, is as follows :—

	Entered.		Cleared.	
	Ships.	Tonnage.	Ships.	Tonnage.
1898	12,523	7,355,000	12,532	7,393,000
1897	11,173	6,708,000	11,299	6,852,000
1896	10,477	6,445,000	10,371	6,300,000
1895	9,443	6,254,000	9,446	6,280,000

We must not forget Bremen, whose new harbour accommodation, costing 100 millions of marks, has contributed immensely to the development of her shipping trade. Besides, by the practical organisation of her cotton exchange, Bremen is now the first cotton market on the Continent, the second in Europe. The American crop last season was 11,500,000 bales, of which not less than 1,709,000 were sent to Bremen.

TABLE I.—INCREASE IN GERMAN TRADE COMPARED WITH THAT OF GREAT BRITAIN, THE UN[illegible] STATES, FRANCE, ITALY, AND AUSTRO-HUNGARY, 1897-8.

IMPORTS.

Country.	1897.		1898.		Increase or Decrease[illegible]
Great Britain		£451,029,000		£470,518,000	+ £19,48[illegible]0
Germany	M. 4,864,644,000	£243,232,200	M. 5,477,648,000	£273,882,400	+ £30,65[illegible]0
United States	$ 742,595,000	£148,519,000	$ 633,665,000	£126,733,000	− £21,786[illegible]0
France	Frs.3,956,027,000	£158,241,080	Frs.4,376,195,000	£175,047,800	+ £16,806[illegible]0
Italy	Frs.1,191,598,770	£ 44,133,287	Frs.1,413,335,346	£ 52,345,753	+ £ 8,212[illegible]5
Austria-Hungary	Fl. 755,300,000	£ 62,941,666	Fl. 830,900,000	£ 69,241,666	+ £ 6,30[illegible]0

EXPORTS.

Country.	1897.		1898.		Increase or Decreas[illegible]
Great Britain		£234,220,000		£233,391,000	− £ 82[illegible]0
Germany	M. 3,786,241,000	£189,312,050	M. 4,001,746,000	£200,087,300	+ £10,77[illegible]0
United States	$ 1,099,709,000	£219,941,800	$ 1,254,925,000	£250,985,000	+ £31,04[illegible]0
France	Frs.3,597,952,000	£143,918,080	Frs.3,503,167,000	£140,126,680	− £ 3,79[illegible]0
Italy	Frs.1,091,734,230	£ 40,434,601	Frs.1,203,569,304	£ 44,576,640	+ £ 4,14[illegible]9
Austria-Hungary	Fl. 766,200,000	£ 63,850,000	Fl. 808,800,000	£ 67,400,000	+ £ 3,55[illegible]0

In view of all these important results, one cannot help deploring the tendency in the German Parliament, and also amongst several industrial firms, towards Protectionism, which leads them to form syndicates, even in articles of first necessity—for instance, in coals, for which a powerful syndicate has been formed in Westphalia, with a view to control the market and raise prices at every opportunity, or whenever foreign competition is not felt. But these reprehensible manœuvres have met with the retribution they justly deserved. The manufacturers of Twenthe—the Lancashire of Holland—resenting the often arbitrary increase in price of Westphalian coal, have decided once for all to shake off the yoke of the above syndicate by acquiring coal mines in Preston, and forming, at Newcastle-on-Tyne, the Preston Coal Company (Limited), with a capital of £650,000. This company will work the mines and dispose of the coal, principally in Holland. The loss of such an important and regular customer as Twenthe is naturally very detrimental to the interests of the syndicate, but the sharp rebuke thus inflicted by the friends of Free Trade on the knights of Protectionism, is well deserved, and has had the result of benefiting England, and of drawing still closer the already excellent commercial relations between the two sole champions of Free Trade in Europe—England and Holland.

But whatever may be said against the formation of syndicates in articles of [illegible]
necessity, the development of German tra[illegible]
undeniable, and the result obtained is not[illegible]
a brilliant proof of the activity of the Ge[illegible]
nation, but it also shows how Germany [illegible]
been well advised in renouncing the [illegible]
protectionism of Bismarck during the las[illegible]
years of his Government, and following a [illegible]
moderate commercial policy. A country [illegible]
as Germany, whose annual exports e[illegible]
£200,000,000, cannot be exposed to [illegible]
quent modifications in foreign tariffs [illegible]
must have stability, at least, for some [illegible]
in the custom duties, and be sure tha[illegible]
different markets do not escape them. T[illegible]
fore, Germany acted in its own intere[illegible]
concluding the different treaties of com[illegible]
mentioned before. But, as in the time [illegible]
Hanseatic League, the Protectionists, far [illegible]
acknowledging how much a more mod[illegible]
commercial policy has contributed to[illegible]
development of German commerce, are [illegible]
tinually on the alert, trying, at every o[illegible]
tunity, to influence public opinion to[illegible]
Protectionism. And this in view of [illegible]
decision which must be taken before lo[illegible]
the subject of the renewal of the treati[illegible]
commerce signed in 1892. It is to be for[illegible]
that the attempts of the Agrarians will [illegible]
rise to lively discussions in Parliament, b[illegible]
doubt the good sense of the German [illegible]
will finally prevail, and the continuation [illegible]
commercial policy so beneficial to German[illegible]

...sisted upon. England has every interest ...atching the agitations of the Agrarian ..., which favours extreme Protectionism, ...nly because if, against all expectations, ...grarians succeeded, the development of ...ian international commerce would be ...ced, but also because the treaty of ...merce of May 30, 1865, between England ...Germany, has really ceased to be operative ... July 31, 1898, it having been denounced ...ngland on July 30, 1897, in support of the ...nercial policy inaugurated in April, 1897, ...anada. As you are aware, the Canadian ...ament passed a Bill providing for the ...ving reductions on import duties:—From ...passing of the Bill until June 30, 1898, a ...ction of 12½ per cent., and from July 1, ..., a reduction of 25 per cent. on goods, ... but few stated exceptions, imported into ...ida from any country whose tariff admits ...products of Canada on terms, on the ...e, as favourable to Canada as the terms ...ie present reduced tariff.

... followed, that, as Great Britain admits ...idian goods free, the reduction applied ...matically to imports into Canada from the ...ier country. But the commercial treaties ...luded by Great Britain in 1862 with ...ium, and in 1865 with Prussia and the ...verein, stipulate that goods imported from ...ium and Germany into the British Colonies, ...l not be subject to higher or other duties ... goods imported into the said colonies from ...it Britain. The question arose, therefore, ...ther owing to these stipulations the reduc...s in the Canadian tariff should not at once ...y to imports from Belgium and Germany, ...out any corresponding reduction on their ... of the duties at present imposed on imports ...i Canada.

...i order to remove all misunderstanding, ...land denounced the said treaties as from 31st July, 1898. But while, by this measure, ...y obstacle was removed which heretofore ...ented the English Colonies from freely ...pting whatever fiscal treatment they might ...ose to apply to imports from the mother ...ntry, the commercial relations between ...land and Germany would have become, ...i the 31st July, 1898, uncontrolled by treaty. ...s in view of the important commercial ...tions existing between the two countries, ...ld have been detrimental to both of them. ...his side of the question did not escape the ...ernments of the two countries, and as there ... scarcely time to arrive at a final under...iding on the subject of a new treaty of commerce, it was stipulated on the 11th June, 1898, that, while continuing negotiations in favour of a new treaty of commerce, Germany would grant up to the 30th July, 1899, to England, all the advantages which are granted by the German Empire to the subjects and products of the most favoured nation, while Germany is, at present, in Great Britain, and in all British possessions (with the exception of Canada), subjected to the the lowest customs tariff rates.

In a word, a prolongation of the treaty of 1865 is temporarily secured, and, until a final treaty is concluded, it will be well to take into account the Protectionist tendency of a great number of the members of the German Parliament, although, as I have said before, there is no doubt that, in view of the conciliatory and open spirit which underlies the relations of the Governments of the two nations, a final understanding will be arrived at on the existing basis, and this time, we hope, not for a short period. Germany has every interest to come to an understanding, as England is one of Germany's best clients, buying much more from Germany than Germany does from England.

In 1895, Germany exported to England only £27 millions; in 1896, £27·6 millions; in 1897, £26 millions; and in 1898, over £28½ millions; while England exported to Germany £20½ millions in 1895, £22·2 millions in 1896, £21·6 millions in 1897, and £22·5 millions in 1898.

Taking these figures alone, it would appear that England is constantly a debtor to Germany, but we enter here on a question very difficult to solve—the balance of trade. Nothing is so difficult as to strike this balance. To come to a right conclusion, the figures of imports and exports are not conclusive. The bank commissions, interests, insurance premiums, freights, arbitrage in foreign stocks, coupons, and many other statistics must be taken into account. These are uncertain quantities, and make it difficult to arrive at anything like reliable results.

The only barometer which, to a certain extent, can guide us on this subject is, and will always be, the rate of exchange, and it is certainly remarkable that, notwithstanding the above figures, and the fact that the rate of discount of the Imperial Bank of Germany and that of the open market have been, in 1898, nearly constantly above the official and market rate in London, the rate of exchange on London in Berlin has neither in 1898, nor in 1899, gone down, one single day, to the point

at which it would have been possible to send, with profit, gold from England to Germany. On the contrary, the rate of exchange on London in Berlin has several times even reached a point at which gold exports from Germany to England would have been possible. In January, 1898, the lowest quotation (for eight days) of the rate of exchange on London in Berlin was 20·375, in February, 20·42; in March, 20·45; in April, 20·49; in May, 20·445. During the latter two months the rate of exchange even reached the point for the export of gold from Berlin to London, the highest quotation being 20·53 and 20·53½; in June, the quotation was again 20·375; in July, 20·37; in August, 20·395; in September, 20·30; in October, 20·37; in November and December, 20·40. At no time, therefore, did the rate of exchange permit of the export, with profit, of gold to Berlin, although several times Germany sold large amounts of foreign securities, notably Italian stocks, mostly purchased by France on the signing of the treaty of commerce with Italy, sales which were settled principally in the international *valuta par excellence*: bills and cheques on London.

The continuance of a rate of exchange adverse to Germany may be partly due to the fact that the Deutsch - Asiatische Bank, representing the leading German banks, took up one half of the 4½ per cent. Chinese loan of £16,000,000 (the other half being taken up by the Hongkong and Shanghai Banking Corporation), and partly to larger imports of food stuffs, to meet the wants of the ever-increasing German population, and of raw materials to cope with the great development of industry.

As we have seen above, the total imports for 1898 attained the imposing figure of £273,882,400 (5,477,648,000 marks), exceeding the exports (£200,087,300, or 4,001,746,000 marks) by £73,795,100 (1,475,902,000 marks).

This great excess of imports over exports should not give rise to any surprise or uneasiness. Just as the millions and millions of pounds received by England for freights, interests, commissions, and for the construction of ships for foreign account, &c., enable her to make up the difference between the exports and imports, and to pay for the food, she must import for her population, and for the raw materials used in her home industry, so Germany also receives with her extensive shipping, banking, and industrial business, large remittances from abroad in the form of freights, commissions, interests, &c. The money spent by the foreigners who frequent her watering plac[es] study at her universities is also an impo[rtant] item. Besides, the interest and divid[ends] on the many millions of foreign securities [held] in Germany must also be taken into accou[nt].

There is not, therefore, the slightest r[eason] for alarm. The situation of England [and] Germany is, on this point, identical and [per]fectly safe, on condition, of course, that [they] continue to increase their national labour [and] neglect nothing to increase their exports. [To-]day, China must emerge from its Ea[stern] lethargy, and will have to answer the ca[ll of] Europe, inviting her to open the count[ry to] progress and civilisation. To-day A[frica] is yielding more and more her treasur[es to] energetic and enterprising countries, Eng[land] and Germany. These two great comm[ercial] nations have, in those regions, a vast fie[ld for] their activity and energy, and enough to oc[cupy] their industry and commerce for many y[ears] and far from competing with each other [the] Governments of the two nations have f[ound] and, no doubt, will find in the future, [many] opportunities to work together, in perfect a[gree]ment, in the interest of their commerce, [and] in the interest of peace, justice, and civ[ilisa]tion. Germany agrees entirely with the p[olicy] of England, who, concentrating her effor[ts to] maintain her own trade, claims only to sha[re in] any advantage obtained by any other na[tion], just as any other nation is free to share in [any] advantage obtained by England. This p[olicy] of England, equitable and just, and of a n[ature] to give great results, corresponds entirely [with] Germany's own views.

The German Government is, therefore, g[iving] its entire support to the policy followe[d by] England in the Far East, where the B[ay of] Kiao-Tchaou was occupied after the murd[er of] the German missionaries in the provin[ce of] Shantung, and a squadron sent, under the [com]mand of Prince Henry; and, as we have [seen] above, half of the Chinese loan of £16,000,000 was taken with England. In a word, [Ger]many has seen the wisdom of securing [in] the interest of her commerce and indust[ry a] firm footing in China and of maintaining [and] enlarging her influence in those reg[ions]. German industry requires the Chinese ma[rket] all the more, now that the United States, [who] formerly were such good clients of Germa[ny]

* According to a statement made by Count von Posad[owsky], Secretary of State for the Interior, in the Reichst[ag] February 11th, 1899, in 1890 American imports from Ge[rmany] amounted to $99 millions, in 1896 to $94 millions, in [1897] $111 millions, an exceptional increase due to the speci[al cir]cumstance of the sugar trade, but in 1898 imports from

ly manufacture more and more themselves y require, but even compete relentlessly Germany on all the markets of the Far According to a recent report of the h commercial mission sent to China in to study the commercial and industrial ion, German commerce in China has ped during the last four years 70 per In 1892, 78 German firms established elves in China; in 1897 there were 104. erywhere else, so in China, England has on's share of the trade, but Germany s immediately, coming even before Japan. 97 German exports to China amounted to 2,500 ($46\frac{1}{2}$ millions of marks), while sh exports to China in the same year were 2,000, and in 1898 £5,044,000.

ides, as has been recently stated in the an Parliament by Herr von Bulow, Secre- f State for Foreign Affairs, the German re, which has a right to railways and mining ssions in Shantung, intends to build a y between Kiao-Chau and the Hoang- In connection with the construction of ys, a contract was about to be concluded en the German Empire and a syndicate of ading German East Asiatic houses for rmation of a joint stock company with at at Tsintau and a capital of over 50 ns of marks. In the event of the profits sufficient the German Empire would ipate in them.

rything shows that Germany, which, as s England and France, has sent, in 1897, sion to China, to study the industrial and ercial situation of that country, will try ke a large share in the trade of the Far Thanks to the enterprising spirit of her ren, thanks to the tenacity of her efforts, any has already made great progress in direction, and everything indicates that will try in the interest of her commerce industry to extend her operations in these tries where there is yet so much to be , where there is room for everyone. ng the last thirty years, Germany has d no effort to increase her production, h exceeds now the amount she can absorb lf, and, therefore, she is obliged to find markets.

t to protect these markets, to give courage energy, to defend eventually the interests of those of her sons who, in these distant lands, work to extend national commerce, a powerful navy is necessary, and Germany neglects nothing in that direction. Especially the Emperor William has devoted all his energy, talent, and firmness, to endow Germany with a strong navy. The struggle in this direction with the German Parliament never discouraged him, nor turned him from his design, and whatever obstacle arises will be overcome by the energetic efforts of the man who wishes the commercial greatness of his country, who sees to what extent Germany has already succeeded, and who feels what an immense future is in store for her.

This is clearly shown by his speech delivered at Kiel on the 16th December, 1897, when his brother Henry was starting for China at the head of the German squadron, when he said:—

"Under the protecting banner of our German ships of war, our commerce, the German merchant and German vessels must now obtain those rights which the foreigner concedes to all nations. Our commerce is indeed no new creation. The Hanseatic League was in olden times one of the mightiest enterprises that the world ever saw. The German towns were once able to fit out fleets, such as had never been seen before. But the League decayed, and inevitably declined, because one of the two conditions of its maintenance was lacking—the Imperial protection. The first preliminary condition, the German Empire, has been created. The second condition is also present. German commerce flourishes and develops, and it can only develop in prosperity and safety when it feels safe under the Imperial power. Imperial power means naval power, and naval power and Imperial power are implicitly dependent on each other; the one cannot exist without the other."

Besides, it is not only Germany who increases her navy, everywhere we see the same thing. To all commercial nations a strong navy is of vital importance. For Germany, the increase of her navy will cost about £20 millions (400 millions of marks), extending over a number of years.

The construction of these ships has, of course, contributed to the activity of Germany's industry, already so busy. This is amply proved by the movement of the iron trade:—

The imports amounted in tons to:—

In 1898.		In 1897.	In 1896.	In 1895.
523,807	against	564,745	421,426	258,227

had declined to \$70 millions. In 1890 American exports rmany had reached the value of \$86 millions, in the ial year of 1898 they had increased to \$155 millions. The e of America's trade with Germany in favour of ts had in 1890 been \$13 millions; her balance of trade our of exports to Germany has now reached \$85 millions.

The exports amounted in tons to :—

In 1898.		In 1897.	In 1896.	In 1895.
1,626,130	against	1,392,953	1,518,620	1,527,894

That is to say that the exports of 1898 exceeded those of 1897 by 233,177 tons, or nearly 77 per cent. It will be seen from these figures how favourable the situation of the iron industry is, which is due to the active demand for machinery, the construction of railways, and also to the demands of electricity, the development of which is increasing more and more in Germany.

Indeed, one can safely maintain that in electricity Germany is at the head of all nations. According to the "Bulletin de l'Office du Travail," the length and the number of cars of electric rail and tramway lines in Europe was as follows :—

	Length in kilometres.		Number of cars.	
	1897.	1898.	1897.	1898.
Germany ..	642·69	1,138·20	1,631	2,493
France	279·56	396·80	432	664
Great Britain and Ireland	127·45	157·20	195	252
Italy	115·65	132·70	289	316
Austria-Hungary	83·89	160·50	194	243

The German banks naturally found in the development of commerce and industry a vast field for their activity. Their issues amounted to :—

In Millions of Marks.				
1894.	1895.	1896.	1897.	1898.
1,419	1,374	2,088	2,013	2,697

of which—

In Millions of Marks.					
1894.	1895.	1896.	1897.	1898.	
168	389	535	668	1,002	were in various stocks.
203	43	34	25	146	„ German Loans.
189	73	333	167	326	„ Foreign Loans.
95	229	307	283	477	„ Industrial Shares.

These are big figures, and it would be rash to say that all these issues were successful. Here it will be well to remember the words of the great French financier, Isaac Pereire : "Souscrire n'est pas placer et placer n'est pas classer."

But, on the other hand, it must not be forgotten, that the extensive development which commerce and industry has taken in Germany, has greatly benefited the German people. Many fortunes have been made, and from the middle classes these fortunes have spread rapidly to the working classes.

Already in 1893 the well-known German professor, Schmoller, declared before the investigation committee of the Bourse that, working on official statistics, he found that the German nation saves every year bet[ween] 2,000 and 2,500 millions of marks, of which 1,000 millions were invested in stocks, [and] since 1893 the general wealth has greatly increased, as is proved by the official stat[istics] showing, that during the last three years th[e in]come and value of property in Germany [has] increased nearly three milliards of marks, [and] by the ever-increasing receipts of the sav[ing] banks, which in 1893 were only 798 mill[ions], in 1895 already 981 millions, in 1896, 1,039 [and] in 1897, 1,082 millions of marks.

These and other statistics show clearly [that] the purchasing power of the German n[ation] has largely increased. Besides, the [con]version of German and Foreign Govern[ment] stocks induced the greater part of the pu[blic] not satisfied with the moderate interest off[ered] to desert this sound department of the Bo[urse] and to take up industrial shares, thinking [that] against the greater risk attending these s[hares] there was, on the other hand, a chance o[f] dividends and higher quotations.

In a word, these considerations and [the] increase of wealth contributed much t[o the] success of many of the issues. But this su[ccess] would never have been as great had it not [been] for the law of the 22nd June, 1896, on B[ourse] transactions, prohibiting all time-transac[tions] in industrial stocks. The Agrarian p[arty], always jealous of the importance of the [Ber]lin Bourse, and of the quickness with which [im]mense fortunes were made, thought that by thi[s] a terrible blow would be dealt to the Ge[rman] banks and bankers who made such large p[rofits] out of the flotation of new companies, issu[es] loans, &c. The contrary happened. In[deed] as will be seen from the above figures, [and] those that are given further on, never ha[ve] flotations of new companies been more num[erous] in Germany ; never was banking business [more] active there.

Then, since the prohibition of time-tra[nsac]tions in industrial shares, the banks found [po]employment for their capital by facilit[ating] the cash bargains of the public, whor[...] prosperous conditions of the industry ha[...] escaped, and who subscribed with even [...] eagerness to the issues of the bank[...] generally these institutions only intr[o]duc[e] to their clients good sound business. [...] Germany, not only is the law on B[ourse] transactions stringent, but no issue can [...] place unless the prospectus has been app[ro]ved by the Bourse Committee, which is com[posed] of the *élite* of the bankers and bank man[agers].

The banks had also to procure mon[...]

lustrial concerns so busily engaged in ig new ships, and numerous railways irkey, China, and other countries. :s, they had in many cases to advance on stocks subscribed by the public, lthough nearly every bank raised its l, money was continually in great id, necessitating a repeated rise in the of discount of the Imperial Bank of iny. On the 9th of April, 1898, that vas raised from 3 to 4 per cent., on the of October from 4 to 5 per cent., on the November from 5 to 5½ per cent., and on th of November to 6 per cent. Only since the foundation of the bank, in 1875, ie discount been as high (in 1877 and but the bank had no choice. For g to face large demands for discount, the had several times exceeded the maximum it fixed by law for the uncovered circula- f bank-notes, and the gold reserve had on the 30th of September, 1898, to illion marks, on the 7th of October to illions and it was only by heavy pur- s of gold on the English market, that the e was, on the 15th of December, brought 575 million marks.

London and Paris markets, of course, ed with interest the situation in Germany, ontinued development of her commerce ndustry. The success which crowned nergetic efforts of the German people aroused, in some quarters, feelings of isy, but a discount rate of 6 per cent., as is a rate of exchange constantly against any, showed clearly enough that the ry was advancing a little too quickly, vhen some of the German banks began to , on a rather large scale, three months' r, on London and Paris, certain English s hesitated to discount these bills. embering how in 1866 bills drawn against r and cheese were readily discounted at cent., while the discount of bankers' bills declined even at 10 per cent., the English s showed themselves unwilling to discount d of paper refused by the Imperial Bank ermany itself. Indeed, the Imperial Bank ermany only admits for discount paper nating from purchases or sales of goods, les of commerce, or drawn against hts, insurances, &c., but does not admit s based on credit alone, bills which are d in Germany "Finanzwechsel."

iese drawings were not, however, extra- nary, as it was only natural that the German ers, so skilled in matters of arbitrage, currency, and finance, should take advantage of the difference between the high rate of discount applied in Germany, and the much lower rates in London, Paris, &c., especially at a time when, the rate of exchange on foreign countries in Berlin being very high, the risk of losing on the exchange was reduced to a minimum. Nobody can dispute that the English money market, which, to a great extent, owes its position of being the first monetary market in the world to the application of sound business principles, that this market, so brilliantly represented here this evening by several of its most influential members, has a perfect right to insist upon exercising its own discretion as to what paper it shall discount; but it is to be regretted, especially at a moment when the situation in Berlin was already uneasy, that rumours were put in circulation concerning certain German banks and concerning the situation of the German markets which were without the slightest foundation. Indeed, as soon as it was known in Berlin that London looked with disfavour on bills which, as I have explained before, had only been drawn to take advantage of the difference in the rate of discount, when at the same time it was thought that the rise in the rate of discount of the Bank of France, on the 20th October, 1898, from 2 to 3 per cent. might be a warning not to encourage too many negotiations in the said Finanzwechsel, the German banks did not hesitate a minute to redeem their drafts immediately, giving in this manner another proof how liquid and strong they were, and how wrong people were in speaking of difficulties on the Berlin market, whose position was perhaps tight for a moment on account of the great demand for money, especially at the end of the year, but which has always been perfectly able to meet its liabilities. Indeed, it is not too much to say that the strong desire which characterises in every country all members of the Stock Exchange and banking business to fulfil their engagements punctually, exists to the highest degree in Germany, where the sense of commercial honour is cultivated by every merchant.

But the policy followed by the English and the French banks concerning the German drawings has been an excellent lesson to the German banks to rely only on their own resources, and not to issue any more bills based on credit alone, the creation of which might give rise to wrong interpretations, and to limit their operations to figures more in keeping with their available resources.

TABLE II.—POSITION OF THE SEVEN LEADING BANKS IN BERLIN AT THE END OF 1898.

(In Millions of Marks.)

	Capital	Reserve.	Debtors.	Creditors	Deposits.	Acceptances.	Gross Profits.			Profits on current banking business.			Profits on Stocks, Syndicates, &c.		
							1898.	1897.	1896.	1898.	1897.	1896.	1898.	1897.	1896.
Deutsche Bank	150	45·3	238·8	322·4	121·7	128·2	28·018	20·587	18·496	22·773	16·198	14·996	4·774	3·899	3·032
Disconto Gesellschaft	115	36·2	158·8	183·3	—	53·4	17·466	17·295	16·931	11·916	10·740	10·382	4·152	5·350	5·182
Dresdner Bank	110	27·5	230·7	156·4	55·2	124·1	16·834	14·078	12·110	13·792	19·409	9·393	2·896	3·579	2·181
Darmstadter Bank.........	105	22·3	77·1	56·9	—	39·1	13·010	10·486	10·625	8·252	5·891	5·851	3·081	3·110	3·037
Berliner Handelsgesellschaft	80	22·1	111·2	80·3	—	46·8	10·641	10·261	9·329	7·791	7·520	7·081	2·453	2·455	1·797
A. Schaaffhausenscher Bankverein	75	11·3	124·2	91	2·8	59·1	9·307	8·180	6·874	6·347	5·433	4·854	2·457	2·315	1·622
Nationalbank für Deutschland...	60	10	61·8	66	—	22·8	7·697	6·982	6·270	5·361	4·708	4·366	1·931	1·908	1·603
—	695	174·7	1002·6	956·3	179·7	473·6	—	—	—	—	—	—	—	—	—

The balance-sheets for 1898 of the leading German banks clearly prove that there is not the slightest reason to be alarmed about the situation in Berlin (Table II.).

Of course, these balance-sheets show how active business has been in 1898, how largely commerce and industry, as well as the public, have had to appeal to the banks; but they show also, that the situation is perfectly normal, perfectly safe, and that the banks have found in satisfactory dividends, and in several cases in higher dividends than those of 1897, the reward for their skill and energy.

While on this subject we must not overlook the very different way in which English and German banks are working. Where the former almost limit their transactions to current banking business, strictly speaking, and, by the application of sound financial principles inspire that confidence without which no bank can exist (and more especially banks who receive millions and millions on deposit) the German banks not only do current banking and arbitrage business on a large scale, but contribute also to the development of commerce and industry by financing the different industrial, railway, shipping, and other concerns, forming syndicates to take over Government and other bonds. In a word, their mode of working differs in more ways than one, from that of the English banks. Both systems applied with prudence and skill, have given, however, excellent results, and while the English banks cannot be too highly praised for the way in which they conduct their business, the Berlin banks, of more recent origin, have by their energetic efforts been very useful to German commerce and industry, contributing, in a large measure, to the expansion of German trade and so making Berlin one of the leading financial markets.

But while the deposits in the English banks continually increase, attaining now nearly ... millions of pounds, the figures shown by the German banks are far behind. The ... deposits at the German banks were in 18.. only 39 millions (760 millions marks) in 1890, 39·6 millions (792 millions of marks), 1892, 39·45 millions (789 millions of marks), 1893, 39·9 millions (798 millions of marks), 1894 48·5 millions (970 millions of marks), 1895, 49·5 millions (981 millions of marks), 1896, 51·9 millions (1,038 millions of marks), and 1897, 54 millions (1,080 millions of marks). For 1898 the total deposits of the seven leading German banks were ... 19 millions (380 millions of marks). An...

he Deutsche Bank, so well represented London market, figures with 6·08 millions millions of marks). At one moment it .id that this establishment intended to r its deposit department to a special ny, with a capital of 60 millions of (£3 millions). In order to carry out heme, the share capital of the bank was ncreased by 30 millions of marks from 180 millions of marks.

although nothing definite has been yet, it is highly probable that in the iture the Deutsche Bank will have to in- its capital, and, in any case, many German banks have decided to do so. erliner Handelsgesellschaft intends to se its capital by 10 millions, the Dresdner by 20 millions, the A. Schaaffhausenscher erein by 25 millions; in a word, the ntation of the capital of many other to the extent of, roughly speaking, llions of marks is contemplated. These augmentations of capital may, to a n extent, be justified by the great ex- n of German trade, but it should not gotten that one of the main factors has contributed to that development is aceful policy constantly followed by the an Emperor and the German Government; though there is, at present, no reason to hat any political complication which force Germany to interfere may arise, litical horizon is not altogether cloudless, ie Berlin banks would do wisely not to go st, inasmuch as money shows again vhere a certain tendency to rise in value, ally in Germany, where, after a certain at the beginning of the year, rates are harder.

eady—and we are only at the end of n—the official rate of discount in Germany 4½ per cent., and if business continues to active as it is now, we may soon see r rates. Since 1895 the value of money onstantly increased in Germany. For year the average rate of discount was per cent., for 1896 3·65 per cent., for 1897 per cent., for 1898 4·26 per cent., and the 19th November, 1898, till the 14th ary, 1899, Germany was suffering under a rate of 6 per cent., a rate which was ed on the 14th January, 1899, to 5 per the 20th February, 1899, to 4½ per cent. 898 the Imperial Bank of Germany was ed to exceed 16 times the legal maximum er uncovered circulation of bank-notes, ust 9 times in 1897, and 6 times in 1896. That legal maximum was, when the Imperial Bank was created on the 14th of March, 1875, fixed at 250 millions of marks, on condition that whenever any of the other 32 banks of issue (entitled to issue 135 millions of marks), renounced such right, it should be transferred to the Imperial Bank of Germany. Twenty-five of those banks having renounced their right of issue, the Imperial Bank of Germany was authorised to issue uncovered notes up to 293·4 millions of marks. Every amount issued by the bank in excess of that limit, is subject to a Government tax of 5 per cent. This system differs entirely from that applied by the Bank of England, as, according to the Bank Act of 1844, the Bank of England must hold gold for every banknote issued beyond the legal maximum (now £16,800,000), whilst the Imperial Bank of Germany can issue any amount of notes beyond the legal maximum, provided the bank pays to the Government a tax of 5 per cent. In Germany, this system is called the *indirecte contingentirung* whilst the English system is called the *directe contingentirung*.

But since the creation of the Imperial Bank of Germany, in 1875, trade and commerce have developed in a remarkable manner. In 1875, Germany's population was only 42½ millions of inhabitants; it now exceeds 54 millions. Her exports were then 2½ milliards of marks; now 4 milliards. The railway system measured then only 28,000 kilometres; now 47,000. The railway goods traffic was in 1875 only 90 millions of tons; now 222 millions. In a word, every branch of industry, commerce, and shipping, has immensely increased, whereas the amount regarding the issue by the first institution of the country of uncovered paper currency, beyond the legal figure, is still the same. A Bill has, therefore, been introduced in Parliament raising the maximum of the uncovered paper circulation of the Bank, free of tax, to 400 millions of marks. The same Bill proposes also to raise the capital of the Bank from 120 millions to 150 millions of marks. While in France and in other countries the capital of the institution having the right to issue banknotes is considered merely as a reserve (the Bank of France, according to its Articles of Association, has no right to employ its capital or reserve for its current business, but must invest it in French Rentes), the Imperial Bank of Germany has not invested its capital in Government stocks, but uses it in current business. Therefore, by the increase of its capital by 30 millions of marks, and

of the maximum of the uncovered paper circulation, free of tax, from 293·4 millions to 400 millions, the Bank will be in a much stronger position, and better able to grant on a larger scale than before, the facilities required by trade and industry, and to extend the scope of the valuable services rendered during the last 25 years.

The discussions concerning the new German Bank Act have again shown that the Protectionist party is always in the field, trying to make of the Imperial Bank of Germany a State Bank, but their efforts up to now, have been in vain and will probably be in vain, for the majority of Parliament, representing the general feeling of the country, have already refused to listen to proposals so contrary to the interests of the nation and to modify the present state of things. The Imperial Bank of Germany, so ably managed by men of great experience and talent, has worked too well on the present system, for the efforts of the Protectionist party to have the slightest chance of success in Parliament. Some modifications in the capital or in the Government share of the profits may be introduced, but there is not the slightest doubt that the Imperial Bank of Germany will continue to work on the existing system.

I have now reached the end of my task, and it remains for me to thank you for the kind and undivided attention with which you have followed me. I have tried to bring before you the progress and commercial development of a country in which I have lived several years, where I have been able to study the economic, financial and monetary position, where I have seen how much is done to make Germany one of the greatest commercial nations of the world. It is obvious, that each of the subjects treated deserves a further and more detailed examination, but I have already taxed your patience to excess, troubling you with many figures. Yet I have tried to bring some interesting matters before you, in as popular and clear a manner as I could. And if I have succeeded, in showing that Germany is a rival not to be despised, if I have succeeded in inducing you to work with all energy and skill in the interest of England's trade, I shall consider myself fully rewarded for the time and pains I have bestowed upon my task. With the great energy and perseverance of the English nation, with the sound business principles and strong spirit of self-reliance which they constantly display, I am convinced that Great Britain will not be distanced by any nation, t
many, many years, that country of p
freedom will continue to be at the head
commercial nations of the world—will
faithful to her trade policy, that is to
the policy of Free Trade, which has so
benefited her people, and which, in th
run, will prove to be the best commercial

But to maintain that position, she
neglect no opportunities, she should dev
her energy to extend her share in the
trade. For trade and commerce are the p
interests of the nations. They may d
languages, laws, customs, history, trad
all, however, have but one common ultim
ject in view; all are animated by the san
bition; all turn every force at their com
into one and the same direction—the a
tion of wealth and power, through trad
commerce. And that nation whose tra
commerce are most extensive and wide
is the nation whose wealth and power
greatest, which will do most for the
race, carrying civilisation, justice, and fr
to the uttermost parts of the globe.

DISCUSSION.

The CHAIRMAN said it was always a plea
listen to a man who was a thorough master
subject, and he was sure they would agree wi
in thanking Mr. Rozenraad for the paper w
had read—a paper of the most comprehensi
exhaustive kind, which had given a complete
of the present commercial position of Ge
and which had explained, in a most lucid
the causes of what was a very rem
feature in the industrial and commercial prog
to-day, namely, the very great progress
Germany had made in the international trade
world. He quite agreed with Mr. Rozenraad
very great deal depended upon the principle
dom by which Germany had been animated in
ing forward her trade, and he quite shar
opinion that England need not feel the least
of jealousy at the progress of Germany. H
saw in the newspapers remarks comparing the p
made by one nation or another, and suggesti
England was on the decline because other
were advancing, but that was a very narrow a
proper way of looking at a subject of this kind
further that other nations advanced in prosperi
the more they grew in wealth, the better it
this country, as they became more valuable cus
of England, and every day as Germany impro
position so would she become a better cu
of Great Britain. Now, not only freedo

necessary for Germany's improvement, but ,ere other virtues which she had developed of years. What a different man the German of was from the German whom some remembered 50 years ago—a citizen of a small Prin- or State, with nothing to excite his of emulation, with no great spirit of patriotism ing his heart for the great nation to which onged. The wars from the year 1860 to 1871 anged all that. A successful war, which d a nation to unity and strength, developed all nliest features of the inhabitants. They re- l their self-respect, were nerved to great ises, and carried on with a hope and spirit of y, and a determination to succeed that was vn to them before. That was what had d the German character from what it was 40 or s ago. He quite agreed with Mr. Rozenraad ermany's commercial development had been markable, especially in ocean-going steamers, y of them were of an exceptional character, re carrying a constantly increasing trade. Nor nly that Germany had prospered at home, for e going to distant possessions would find that n merchants and bankers were prospering there. was a great German club, for instance, not n Manchester but in Calcutta, under the flag. Germans under the British flag were g on trade in India, South Africa, and else- This was one reason why the two nations live happily together, and should make them ine to do the best they could to promote the of the world. He believed that the era which ad just passed through in the last 10 or 15 the era of international suspicions and hatreds, nstant dread of war—was now drawing to a and that they might hope for a better time rmaments would be reduced and good feeling n the various countries would prevail. There ne feature of German progress which had not ommonly noticed. In England, a great deal en done in railway enterprise, but they had had any of the enormous physical obstacles s existed in the case of other nations; ad not had thousands of miles of desert erse or lofty mountains to level or pierce unnels. One of the most curious features lern life was that Continental nations had ed railway enterprise in a very remarkable and a degree which had hitherto been un- in England. The building of great Continental s which was now going on, and the levelling y mountains was something new in the of railways. He would give an illustra- f what they might accomplish in Europe When he was in the South of France a time ago, he noticed there was a very invasion of Germans into that part of the y, and also into the north of Italy, and upon inquiry he found that the Germans poured in e numbers every year. Now what was the reason of that? It was simply on account of the Alps having been pierced by numerous tunnels, or crossed by railways, Italy being no longer shut out from Germany by an impassable barrier. At one time goods could only reach Italy from London by a long sea voyage, but now that the Alps had been traversed in half-a-dozen different directions this was not the case. The result was that the two nations had been brought more closely together, and a great interchange of trade had sprung up. In some of the Foreign Office despatches from our consuls in Italy, the usual lamentation was made about the decline of British merchants. The fact was that the British merchant was not less wanting in enterprise, but the German had been brought nearer than he was before, and was so able to send his goods through the Alps at a cheaper rate than the English merchant could hope to do. When at Lucerne he compared the statistics of people who passed through, and he found that the number engaged in business was greater than those on pleasure. The very same thing was being done over the whole of Asia by the construction of these railways. Germany and Russia were taking the initiative in that part of the world, and England had lost ground by not seeing what an enormous field for new enterprise was being opened in Asia. They had concentrated too much attention on Africa in recent years. Beyond Egypt and South Africa, he did not see any great prospect of wonderful new markets which people expected to find in the illimitable regions of unproductive country inhabited by warlike tribes. There were far more fruitful fields in Asia, which had been left uncultivated, and which the Germans and Russians had seen the possibility of turning to advantage. Some years ago, Lord Salisbury called attention to the necessity of looking at large maps, but the world had become very much smaller since those days. When Lord Salisbury spoke Moscow was thousands of miles distant from Pekin, but it was now within a few days' journey. The opening of the railways across Asia would have as much influence upon the development of trade as the opening of the Suez Canal had. In conclusion, he proposed a hearty vote of thanks to Mr. Rozenraad.

Baron VON LINDENFELS (Consul-General for the German Empire) said he must congratulate Mr. Rozenraad upon the complete manner in which he had dealt with this subject. Nothing was more useful for forming a proper opinion upon the subject than the frank and impartial criticisms given by an outsider whose knowledge of the subject could not be doubted, and this gave a good guarantee that it had been treated with impartiality and fairness. He was convinced that German commerce was in a steady state of development. It was not a development that need give rise to any serious apprehensions to England, whose commerce and industry was at all times in such a high state of development that it could compete with other countries. Germany, as a

young commercial nation, would have more trouble and more difficulty in competing with England than with other nations. There was no doubt there would be a great deal of competition in the future between these two countries, but their interests were, to a great extent, much the same, as both exported the same products to different markets. But there was no reason why this competition should not be a friendly one. The United States had great chances of enormous commercial development, whilst Germany, which had already reached certain limits with regard to population and the like, could not easily make much further progress. He could see no reason why there should be any jealousy between the two countries in the future; and, for his own part, he hoped that the friendly relations which had hitherto subsisted would continue to the benefit of both countries.

Mr. HERMANN SCHMIDT said he had been much struck with the remarks in the paper upon the advancement of Germany, and the figures brought forward plainly showed that in spite of the system of Protection which Mr. Rozenraad had criticised, the progress of the country had been most remarkable. The fact was that Germany had never been Protectionist except in self-defence. When the great fall in prices took place, there were only two ways of meeting the difficulty, and in order to check the effect of the fall, Germany was obliged to take up with Protection. When it had served its purpose the Protection system was relaxed. Germany had not passed through the years of commercial depression through which England had passed, and which led a few years ago to so many great failures, culminating in the Baring collapse. It was owing to the wise precautions which the German Government took in counteracting the effect of the fall in prices that that country had been able to progress commercially without interruption. It was not that it had progressed in consequence of Protection, but it was through the protective system being introduced at a time when the fall in prices took place, with the result that they had been able to ward off many of the evil effects of the fall. The banking system in Germany was not quite analogous to that in England, though to say the German banks were not as safe as English ones was going beyond the mark. The banks in Germany were conducted by men of very great commercial experience.

Mr. H. GERLICH (Commercial Attaché, German Embassy), after expressing his thanks to Mr. Rozenraad for his admirable paper, said there was one point with which he did not quite agree, and that was upon the subject of Protection. He believed in Protection, and it appeared to him that this belief was spreading rapidly even in England. In England it had taken only a less offensive name, and was called a countervailing duty. He did not want, however, to discuss the questions of Protection and Free Trade. Every country had to select the policy which it thought the most suitable to itself. If Germany wen
better with Protection, and England found tl
Trade was more favourable to her, no one hac
to interfere. He only could wish that both c
should make rapid progress in prosperity. Th
a country developed its resources, the better i
be for its customers to trade with it. He was c
that if Germany and England worked togetl
result would be increased prosperity of both.

Mr. C. W. STOKES said that he hoped th
ing would make allowance for him if he differ
the author of the admirable paper, and
speakers, in their praise of so-called Free
inasmuch as the trade he had been devoted
was dependent upon — silk manufacturing
practically ruined by the unfair competition
monly erroneously called Free Trade. He con
that the primary duty of the Government of a
was to ensure that the consuming power of a
should support the producers of the nation, bu
England exposed the consuming power of th
British Empire to foreign competition on equa
whilst British producers were handicapped
nations by protective duties almost prohibitory
could not share the roseate views of the future
United Kingdom expressed by the Chairman.
universal application of machinery througho
world, and the protective duties of con
countries, involved inevitable over-production,
would be very serious to the United Kingdo
open ports.

Sir CHARLES MALCOLM KENNEDY, K.C
C.B., said he wished to add his appreciati
the paper, but he would not further dw
points which had already been adverted to.
were two or three matters on which he
like to say a few words. In the first p
seemed to him that the historical and p
aspect of the question of the commercial d
ment of Germany had been well stated b
Rozenraad; but there was one point which
special importance, and which was often over
in this country, and that was the bearing
international commercial relations had on
questions. These engagements were of special
they afforded stability to trade, and, in co
whose political systems differed from ours,
afforded weight to all foreign trade relations. A
point of great importance to which Mr. Roz
had alluded was the varying relations b
German agriculture and trade interests. This
ment opened out a wide field of economic ob
tion, which was very important, and which
with advantage be followed by those who rea
paper in the *Journal*, and who studied t
these two great national interests. Then, whi
action of syndicates, to which Mr. Rozenraa
alluded, was not an unmixed benefit, the Conti
practice of combined action on the part of ma

was of great importance. That was shown in ...tional exhibitions abroad. Foreign industries ... together in putting forward what was ... a collective exhibit; and by that means ...advanced their own trade and national in..., while they avoided the waste of energy ...oney which was occasioned by single and ...ual action on these occasions. Again, he ...t they must acknowledge the very beneficial ... of German official action in commercial ...s. These matters were treated in a systematic ...r by the German Government Departments. ...ad what was wanted in this country, namely, ...cial commercial intelligence department, and ...atters as these were well looked after by the ...ment in Germany, Belgium, and other Con...l countries. In this connection he would ask ...rson who followed up the subject to give their ...on to a recent Foreign Office report on German ... No. 490, of the miscellaneous series. As this ...e last meeting of the Colonial Section for the ...1 he might, perhaps, be permitted to say that ...ght the members owed a debt of gratitude to ... Digby, the new Secretary of the Section, ...ad been instrumental in providing four excel...pers.

...vote of thanks was put and carried unani....

...P. DE JERSEY GRUT writes:—Mr. Rozenraad ... valuable and interesting paper appeared to be ...l by the fact that though Germany's exports to ...Britain are greater than her imports from Great ... by several millions of pounds sterling annually, ...e rate of exchange, as between Berlin and ...n, is always in favour of the latter place. He ...at the difficulties of the question of the ...ice of trade" (on which our forefathers held ...rroneous views), and suggests that the expla... of the above-mentioned apparent inconsistency ... found in commissions, interests, freight, &c. ...is, however, a much simpler explanation. It is ...hat the "balance of trade" as between ...ny and the British Isles is in favour of the ... country, but when the "balance of trade" ...tween Germany and the British Empire ...nsidered, the boot is on the other leg. ... the year 1896, German exports to the ... Isles amounted to 715,000,000 marks; her ...s to 614,000,000 marks. But her exports to ...and Australia amounted to only 78,000,000 ... while her imports from those countries were of ... a value than 270,000,000 marks. It is true ... the case of Canada she imported only 3,000,000 ... and exported 15,000,000 marks worth. On a ...tion of all the imports and exports, as between ...o empires, the balance in favour of the British ...e was about 125,000,000 of marks. Now the ...e of trade as between Germany and the Indian and Colonial members of the British Empire is settled by exchange operations that run to earth at London. Hence it will be seen that it is not to be wondered at that the rate of exchange is practically always in favour of London, and against Berlin. Mr. Rozenraad makes a comparison between the deposits of the English and German Banks, the former amounting to nearly £800,000,000 sterling, while the latter only amount to £54,000,000 sterling. A still more striking contrast can be afforded by mentioning the Australian local bank deposits, which amount to £100,000,000 sterling. It is remarkable that a new country, with only 4,500,000 inhabitants, should have nearly double the amount of bank deposits that an old and really wealthy country like Germany, with 52,000,000 inhabitants, has. Also, that the seven leading German banks have, all told, only the same amount of deposits that one Australian bank—the Bank of New South Wales—has. It would be interesting if, on some future occasion, Mr. Rozenraad would give his views as to the causes of the relative smallness of the bank deposits in the Continental European countries.

Miscellaneous.

LEADLESS GLAZES.

The joint report of Professor Thorpe and Professor Oliver to the Home Secretary on the subject of the employment of compounds of lead in the manufacture of pottery, and their influence upon the health of the workpeople, have been issued as a Blue-book, and the following abstract of its contents is extracted from an article in *The Times*:—

Besides visiting factories of earthenware and china at Stoke, Hanley, Burslem, and other places in the Pottery District, Professors Thorpe and Oliver have visited, either singly or together, the leading manufactories on the Continent, including those at Delft, La Louvière, Maastricht, Copenhagen, Stockholm, Dresden, and the Royal Prussian Porcelain Works at Charlottenburg. Special reports on these visits by Professor Thorpe are appended to the joint report, and the Blue-book also contains a report by Professor Thorpe of experiments on substitutes for raw lead conducted in the Government Laboratory, and a statement, for purposes of comparison, of the special rules for the manufacture of pottery in force in England, and the regulations observed in foreign countries.

The report, which is dated February 21, states at the outset that since the inquiry of 1893, very little of an effective character has been done, or even attempted, to remedy the evil of lead-poisoning, and from the figures given it appears that of the total male workers, in the year 1898, 4·9 per cent. became "leaded," while of the female workers, the proportion is as high as 12·4 per cent. With regard to

obviating the use of lead in glazes, inquiry at first showed that only in a few cases were the results of experiments satisfactory, although in the case of white and cream-coloured ware (as distinct from the use of glazes in conjunction with colours), there ought to be little difficulty in the application of a leadless glaze. In the last six months, however, many successful attempts to substitute a leadless glaze have been made by the manufacturers, and the authors of the report say they "have no doubt whatever that leadless glazes, of sufficient brilliancy, covering power, and durability, and adapted to all kinds of table, domestic, and sanitary ware, are now within the reach of the manufacturer," and that this fact is now becoming admitted in the trade. If, however, the use of lead compounds in glazes is still to be permitted, the report states that much may be done to minimise their evil effects, and that no practical difficulties would result to the trade from the general substitution of "fritted" for "raw" lead. The substitution of a "simple" silicate, where it has been effected, has been attended with advantage so far as plumbism is concerned, though cases of poisoning from it are not unknown.

With regard to the workpeople the report, besides advocating the exclusion of women from certain parts of the work—except where leadless glazes are used—suggests the adoption of expedients to avoid the absorption of lead by the skin in the process of dipping. In foreign factories either the dippers are provided with indiarubber gloves up to the elbow or else the articles to be dipped are held by tongs, while in England the dippers' hands and arms are immersed in the glazing material. Indiarubber gloves have been tried, and though they have not found favour in the Pottery District, a return of them is advised by Professors Thorpe and Oliver.

The report expresses strong dissent from the doubts which have been expressed in some quarters as to the greater susceptibility of women and young persons to the evil effects of the metal; and points out that in certain potteries and lead works in Belgium and in Paris women are not allowed in any circumstances to work in the factories, owing to the recognised destructive effect of lead-poisoning on the power of child-bearing. While not recommending the complete abolition of even married female labour in the potteries, Professors Thorpe and Oliver make definite proposals as to the restriction of female labour, a subject which they acknowledge to have been one of the most difficult problems of the inquiry. The report concludes as follows:—

"The conclusions at which we arrive from the inquiries we have instituted at home and abroad, and from the observations and experiments we have made, are—

"That by far the greater amount of earthenware of the class already specified can be glazed without the use of lead in any form. It has been demonstrated, without the slightest doubt, that the ware so made is in no respects inferior to that coated with lead-glaze. There seems no reason, therefo[re] in the manufacture of this class of goods the o[per]at[ives] should still continue to be exposed to the evi[ls] wh[ich] the use of lead-glaze entails.

"There are, however, certain branches of [the pot]tery industry in which it would be more dif[ficult to] dispense with the use of lead compounds. B[ut there] is no reason why, in these cases, the lead so e[mployed] should not be in the form of a fritted double [sil]ic[ate]. Such a compound, if properly made, is but [slightly] attacked by even strong hydrochloric, acetic, [or] acid. There can be little doubt that, if lead [is] used, the employment of such a compound sil[icate]—[if] its use could be ensured—would greatly dimi[nish the] evil of lead-poisoning.

"The use of raw lead as an ingredient of [glaze] material, or as an ingredient of colours whi[ch are] to be subsequently fired, should be absolut[ely pro]hibited.

"As it would be very difficult to ensure [that] innocuous lead-glaze shall be employed, w[e are of] opinion that young persons and women sh[ould be] excluded from employment as dippers, [dippers'] assistants, ware-cleaners after dippers, and [glost-]placers in factories where lead-glaze is used, a[nd that] the adult male dippers, dippers' assistants, [ware-]cleaners, and glost-placers should be subje[ct to] systematic medical inspection.

"In the 1893 report the medical member[s of the] committee expressed the opinion that 'm[any] factories are wholly, or in part, unfit in a [health] point of view for occupation,' and they sugges[ted that] 'there should be some authority to close t[hem, or] whatever part of them is condemned, on th[e same] principle as dwellings are declared uninhab[itable].' We share this opinion and we concur in the [sugges]tion. Certain of the factories we have inspe[cted are] in the last stages of dilapidation, and it appea[rs] to be well-nigh impossible to introduce into th[em such] re-arrangements or additions as are required [by the] amended special rules."

TEA CULTIVATION IN NATAL.

The picking season in Natal generally com[mences] early in September, and goes on till about the [end of] the following May. The months of June, Ju[ly, and] August are taken up with digging and manur[ing the] land, and pruning the plants. The tea is pic[ked by] the coolies, mule carts in different gangs co[llecting] the leaf. Men and women are employed in th[e pick]ing process. The tea leaf is taken down [to the] factory, where it is "weighed in." When [this is] done, it is spread out thinly on frames cover[ed with] hessian, for the purpose of "withering," in [a tem]perature of 80° to 90°. The United States C[onsul-]General at Cape Town says that, in the [course] of twelve hours, the leaf has become p[erfectly] soft, and produces the same sensation to the

silk handkerchief. The leaf is then passed h shoots into the machine room, where it is l;" the object of this process being to break juice cells in the leaf, and to give the leaf that r twist characteristic of the tea seen in ordinary rce. When the rolling is finished, the sappy, nass is sent down into the cooling chamber it is spread out and submitted to the action of at a temperature of from 60° to 70°. This is tical stage in the manufacture of tea. The eye experienced manager is required to see that the tation is arrested at the exact time, or the tea lose quality, and would acquire an undesirable . The rolled leaf is then passed to drying on which it is spread out thinly and submitted emperature of about 250°, the excessive heat fermentation, and taking all moisture out of f. The now manufactured article is sent on to ting department, where the different grades of Pekoe, Flowery Pekoe, Pekoe Souchong, ong, and dust, are separated by machinery, consists of a huge, revolving screen cylinder, shes gradually getting larger towards the outer that the dust falls from the separating machine nd the Souchong last. It may be observed e smallest leaves on the twig, when picked, he finest tea. The tea is then put into air-ins where it is allowed to remain from two or onths to mature. After this it goes to the g department, where it is put into packets or or the trade.

General Notes.

.POLITAN VAGRANCY.—Another great plague, ing to Her Majesty's Consul in Naples, is to be d from the streets of that city. Begging is abolished. Italy has no "Poor-law," and ovision made for beggars at the so-called osito di Mendicita" has never been effica- Mendicants, if they give trouble to the are put there for a few days at most, and t out and allowed to begin again. The city endid charities, and if these were harmoniously l, a great part of the really deserving indigent be provided for, were it not that every litan has a rooted aversion to being kept inside e of any kind. The municipality proposes to te the worst cases (such as deformities, blind , &c.) among such charitable institutions as are lculated to take care of them, and to provide others by a subsidy of 10,000 lire (£400) ly. Taking each pauper at the moderate ed cost of 20 lire (16s.) per month, 10,000 lire provide for 42, a mere drop in the ocean of litan vagrancy.

RECEIPTS OF PARIS THEATRES IN 1898.—The annual return showing the gross receipts of the principal places of amusement in Paris has just been issued by the Director of the General Administration of Public Assistance in France. The largest amount realised during the period comprised between 1850 and 1898 was in 1889, the Exhibition year, when the receipts amounted to £1,292,000, but with the exception of this year, 1898 showed the largest receipts of any, these amounting to £1,246,000. In 1878, also an exhibition year, the amount realised was £1,226,000, and the lowest amount realised in any one year of the series was, as may be easily understood, in 1871, when only £228,000 were received. Taking the amounts received at each establishment last year, it is found that the Opera, as usual, heads the list with £119,232; then comes the Porte St. Martin with £87,796; and the Comedie Française with £78,088. The Folies Bergère realised £52,748; the Opéra Comique, £48,516; the Vaudeville, £47,564; the Variétés, £44,940; the Nouveau Cirque, £35,580; the Gaîté, £34,920; the Nouveautés, £29,160; the Scala, £28,588; the Gymnase, £28,280; the Casino de Paris, £27,948; Olympia, £26,920; the Châtelet, £24,596; the Palais Royal, £23,812; and the Ambigu, £22,456. The Conservatoire concerts yielded £9,048; the Colonne concerts, £7,328, and the Lamoureux concerts, £6,760.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

APRIL 12.—"Telephones." By JOHN GAVEY. W. H. PREECE, C.B., F.R.S., will preside.

APRIL 19.—"London's Water Supply." By WALTER HUNTER, M.Inst.C.E.

APRIL 26.—"Coal Supplies." By T. FORSTER BROWN.

MAY 3.—"Aerial Telegraphy." By W. H. PREECE, C.B., F.R.S.

MAY 10.—"Fruit Growing in Kent." By GEORGE BUNYARD.

MAY 17.—"The Law of Trade Marks." By J. E. EVANS-JACKSON.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 27.—"Judicial Reform in Egypt." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive. The LORD CHIEF JUSTICE OF ENGLAND, G.C.M.G., will preside.

MAY 11.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore. Colonel GEORGE HERBERT TREVOR, C.S.I., will preside.

JUNE 1.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

APRIL 18.—"Inlaying." By STEPHEN WEBB.

MAY 2.—"Maiolica." By WILLIAM BURTON.

MAY 16.—"The Artistic Treatment of Picture Frames." By J. HUNTER DONALDSON.

MAY 30.—"Wrought Iron Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

PROF. HENRY R. PROCTER, F.I.C., "Leather Manufacture." Four Lectures.

LECTURE I.—APRIL 17.

Primitive methods—Difficulties of investigation—Sources of raw material—Methods of curing—Anatomical structure of skin—Arrangement of hair-pores—Chemical character of skin and epidermis—Manufacture of gelatine—Soaking and softening of hides and skins preparatory to tanning.

LECTURE II.—APRIL 24.

Removal of hair and wool—The staling process—Bacteriological and chemical actions involved—Depilation by lime—Practical methods—Chemistry of liming process—"Buffalo" method—Pullman's indirect process—Use of alkaline sulphydrates—Realgar—Mechanical operations—Deliming processes—Chemical and physical considerations—"Pulling down" with acids—Fermentative methods—The bran drench—Bating and puering.

LECTURE III.—MAY 1.

Physics of tanning—Theory of the pickling process—Mineral tannages—Tawing with alumina salts—Chrome tanning—Heinzerling process—Schultz or "two-bath" process—Basic or "one-bath" process—Iron tanning.

LECTURE IV.—MAY 8.

Oil dressing—The chemistry of the process—Combinations of oil and mineral tanning—Vegetable tanning matters—Chemistry of the tannins—Practical methods—Combination of vegetable and mineral tanning—Currying—The chemistry of oils and fats used—Theory of the currying process.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 10...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. E. T. Hall, "Sanitary Building Construction."
Engineers, in the Theatre of the United Institution, Whitehall, S.W., 7½ p.m. Ewart C. Amos, "Machine Tools."
Chemical Industry (London Section), Bu[rlington]-house, W., 8 p.m. Dr. J. T. W. Th[udichum], "The Industrial Technical Treatment o[f] and of British Colonial Wines."
British Architects, 9, Conduit-street, W., "The Application of Colour to Interior O[rnament] in Relief."
Medical, 11, Chandos-street, W., 8½ p.m
Victoria Institute, 8, Adelphi-terrace, W.C. Mr. T. G. Pinches, "Babylonian Deities."

TUESDAY, APRIL 11...Royal Institution, Albemarl[e-street], W., 3 p.m. Prof. J. Cossar Ewart, "Ze[bras and] Zebra-Hybrids." (Lecture I.)
Medical and Chirurgical, 20, Hanover-sq[uare], p.m.
Civil Engineers, 25, Great George-street, p.m. 1. Discussion on paper by Mr. Hadfield, "Alloys of Iron and Nickel." James Murray Dobson, "Buenos Aires Works."
Photographic, 12, Hanover-square, W., Mr. E. W. Maunder, "The Correct Expo[sure to] be given to Photographs of the Corona."
Colonial Inst., Whitehall-rooms, Whiteha[ll], S.W., 8 p.m. Sir William Robinson, "T[rinidad,] its Capabilities and Prominent Products."
Pharmaceutical, 17, Bloomsbury-square, W.C.

WEDNESDAY, APRIL 12...SOCIETY OF ARTS, Joh[n-street], W.C., 8 p.m. Mr. Gavey, "Telephones."
Geological, Burlington-house, W., 8 p.m. W. J. Sollas, (*a*) "Fossils in the U[niversity] Museum, Oxford" (I. Silurian Echinoi[dea and] Ophiuroidea); (*b*) "The Occurrence of Spicules in the Carboniferous Limestone o[f ...]shire." 2. Mr. C. T. Clough and Dr. Pollard, "Spinel and Försterite from the Limestone."
Sanitary Institute, 74A, Margaret-street, W. Miss Alice Ravenhill, "Practical Hygiene ing in Elementary Schools."
Royal Society of Literature, 20, Hanover W., 1 p.m.

THURSDAY, APRIL 18.. Antiquaries, Burlington-hou[se], 8½ p.m.
Society for the Encouragement of Fine [Arts], Conduit-street, W., 8 p.m. Mrs. Philip N[...], "Some Goldsmiths and their Work."
Sanitary Institute, 74A, Margaret-street, W. Mr. W. C. Tyndale, "House Drainage."
Royal Institution, Albemarle-street, W., Prof. Dewar, "The Atmosphere." (Lectu[re] I.)
Electrical Engineers, 25, Great George-stree[t], 1. Discussion on paper by Mrs. Ayrton Hissing of the Electric Arc." 2. Mes[srs.] Duddell and E. W. Marchant, "Experim[ents on] Alternate Current Arcs by aid of Oscillogr[aphs]."
Mathematical, 22, Albemarle-street, W., 8 p.

FRIDAY, APRIL 14...Royal Institution, Albemarle-str[eet], 5 p.m. Weekly Meeting. 9 p.m. Prof. Rucker, "Earth Currents and Electric Tra[ction]."
Astronomical, Burlington-house, W., 8 p.m.
Junior Engineering, Westminster-palace S.W., 8 p.m. Mr. H. C. Reid, "Piles a[nd Pile] Driving."
Philological, University College, W.C., 8 p.m.
Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, APRIL 15..Royal Institution, Albemarle[-street], W., 3 p.m. Mr. Louis Dyer, "Mach[iavelli]." (Lecture I.).

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mmunications for the Society should be addressed to Secretary, John-street, Adelphi, London, W.C.

oceedings of the Society.

XTEENTH ORDINARY MEETING.

lnesday, April 12, 1899; W. H. E, C.B., F.R.S., in the chair.

following candidates were proposed for n as members of the Society:—

iomas Henry, Avonmore, Dudley-park-road, ks-green.
C. Foster, Sheepcote-road, Harrow.
William John, Finchley and Hornsey-lane,
in, Henry Neville, 34, Devonshire-place, W., 6, Leadenhall-street, E.C.
, Horatio Haliburton, 5, The Cam sbourne, sey, N.
ie, J. R., J.P., Calder-green, Blantyre, N.B.
, Arthur Dingwall Fordyce, A 24, Exchange, pool.
, Charles, 39, Victoria-street, S.W.
s, E. Montague, 162, Romford-road, Strat- E.
Montagu, Bonsor Gold Mining Company, we, Rhodesia.
re, William Alexander, 13, Prospect-hill, hamstow, Essex.
n-Annesley, Lieut.-General Arthur Lyttelton, lemere, Weybridge, Surrey.
zie, Alexander Marshall, 1, Bon Accord- , Aberdeen.
Alfred, 4, Orient-terrace, Manor-road, Liscard, ire.
Carl, 35, Hill-street, Mayfair, W.
Mrs., 40, Thurloe-square, S.W.
Adolphus, 4, East India avenue, E.C.
s, Charles Thomas, Madras, India.
Major John Alfred, Rangoon, Burma.

following candidates were balloted for y elected members of the Society:—

eimer, Hermann L., 55, Redcross-street, an, E.C.
Henry Archibald, Somersall-hall, Chester-
, Julius Charles, 82, Piccadilly, W.

The paper read was—

TELEPHONES.

By John Gavey.

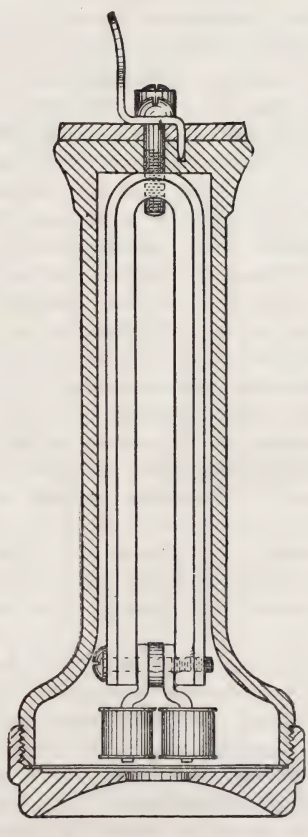
General.

The invention of the speaking telephone, which was the outcome of the labours of Page, Reis, Graham Bell, Edison, Hughes, and numerous successive inventors, has entirely modified the means of rapid and accurate inter-communication, not only within limited areas, but between cities and towns many hundreds of miles apart, and this method of communication, which is proving such a rival to the older form of telegraphy, has aroused such widespread interest that your Council have thought it desirable that a paper on the subject of Telephones and Telephone Exchanges should be laid before you.

The Telephone Receiver.

Although many forms of receiving telephones of varying degrees of merit have been designed,

Fig. 1.



Bell's Telephone.

it is only necessary here to refer to the first perfect articulating telephone that was practically used, namely, that invented by Graham Bell. It may be said that not the least remarkable feature of this invention is the fact that since its introduction, in the year 1877, beyond the mere perfection in its manufacture, it has been found impossible to effect any material improvement in the type of instrument then introduced, when used as a receiver. At the present time the original drawings or diagrams, prepared for the first public lecture on the Bell Telephone, still serve for purposes of illustration.

A very brief description only of this receiver is necessary. Bell's telephone, as now used, comprises a permanent magnet, preferably of the horse-shoe type, with a small coil of insulated wire surrounding each pole piece. Opposite these pole pieces is placed a thin diaphragm of soft iron which is set in vibration when undulating or vibrating currents traverse the coils. This telephone can serve both as a transmitter and as a receiver, but in practice it is now used only for the latter purpose. Fig. 1 illustrates its present form.

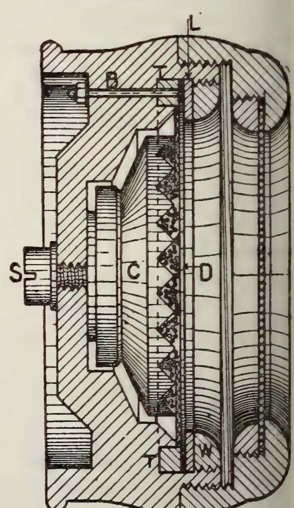
The Telephone Transmitter.

The modern telephone transmitter is based on the discoveries of Hughes and Edison, of the fact that loose or imperfect contacts, preferably of carbon, when subjected to vibrations, vary their resistance to the passage of an electrical current, and that within certain limits this variation bears a direct relation to the amplitude and to the frequency of the disturbing vibrations. Thus, musical or articulate sounds, producing sonorous vibrations in the air, impinge upon a diaphragm and set it in vibration, and if this diaphragm press upon or set in movement loose contacts of a suitable character, a corresponding variation arises in the resistance of the circuit of which these contacts form part, and a current of electricity traversing the circuit can be made to describe precisely the same curves as those due to the sound waves. It is the function of the receiver to convert these electrical curves into mechanical vibrations, and thus to reproduce actual sound.

The action of speaking by telephone thus involves a number of successive transformations of energy. The sound waves, which impinge on the diaphragm of the transmitter, set up mechanical vibrations, which give rise to electrical undulations. These undulating currents traverse the connecting wires, causing variations in the magnetic field of the ing telephone, and setting up vibrations diaphragm similar to those which orig the disturbance. In this manner mus speech are reproduced.

Innumerable forms of carbon micro have been devised. In some cases per hard carbon rest loosely in sockets for carbon blocks attached to the dia of the transmitter; in one form—still used with single wire circuits—a bu carbon rests against the diaphragm, most effective transmitter consists o granules of carbon enclosed betwee carbon discs, one of which is fixed, other free to vibrate. Fig. 2 illustra form at present used by the Post Office. design of a transmitter care must be t provide against the vibrations of the dia causing an actual break of the circuit, gives rise to disagreeable sounds, and speech inarticulate. The two former transmitter are subject to this defect sh speaker shout or approach too closely telephone, but with the latter it is pos speak close to the transmitter, and wi siderable force, without rupture of the so that it is well adapted, not only for in munication on short lines, but also on long trunk circuits.

Fig. 2.



Deckert's Granular Transmitt*

The various types of receivers and mitters are fully described in the tex so that it is not necessary to refer to large at the present moment.

* These two blocks have been kindly lent b Longman and Co.

The Circuit.

ıen the telephone was introduced as a cal instrument it was discovered that it d by far the most delicate detector of ıating or vibratory currents that had been d in the hands of the scientific investi- or the practical electrician. When l to a single wire, the circuit of which :ompleted through the earth, and which n proximity to other circuits similariy l up, innumerable noises were heard the neighbouring wires were worked. rbing secondary currents, some due to leakage, some to electro-static, and to electro - magnetic induction, were ated by the adjacent working currents, ıat if these were used for telegraphic ıses buzzing and frizzling sounds were l on the telephones, of such intensity as nder speech impossible. On the other , if the neighbouring circuits were used ıonically, and were in excess of a certain h, the conversation held on one circuit be heard on all the neighbouring circuits. ı, however, two wires were used to form a lete metallic circuit, and when they were aced in regard to all neighbouring wires he average distance between any one of atter and the two former was the same ghout, then the electro-motive force due duction in one of the wires of the circuit qual to and opposed to that in the other, isturbing currents circulated, there was ıkage from earth, and a silent circuit was ded, in which nothing interfered with actory speech.

early as 1881, when the first Post-office hone exchange was opened, the Depart- erected metallic circuits, and this policy een adhered to throughout. Most of the administrations and companies through- Europe and America, however, started single-wire circuits, and this is one of the ipal causes of the dissatisfaction which members of the public have felt with the hone service. To reduce the overhearing een neighbouring single-wire circuits, it found necessary to use somewhat imper- ransmitters, which only admitted of good ulation when the users spoke in gentle , and even then the circuits were noisy, cient, and unsatisfactory. In justice, ver, to those who started on these lines, ust be said that in the early days of tele- e exchange work there was no form of in- ed wire thoroughly adapted for use for rground purposes, and it was practically impossible to erect aerial wires in the enormous numbers that soon became necessary to provide metallic circuits for the large Exchanges that rapidly arose. Gutta-percha and india-rubber insulated wires were very costly, they took up much space, and their static capacity was so high that the limit of distinct speech was soon reached.

The invention of paper insulated air space multiple cables has led to a revolution in telegraphic practice. They are relatively cheap, they take little space, a conduit that would hardly hold 80 gutta-percha wires will accommodate 408 wires insulated with paper, and the static capacity of the latter is but one-fourth that of the former, which practically means a fourfold increase in the range of speech when underground circuits are in use. Specimens of these cables are exhibited.

All European and American administrations and companies have availed themselves of this new form of underground cable, and at present about three-fourths of the Exchange service in these countries is provided by means of complete metallic loops. Their use is being rapidly extended, so that within a relatively short period the single-wire telephone exchange circuit will be a thing of the past.

It may, however, be well to refer to the fact that for long distance speech, over trunk lines connecting distant places, we are still practically restricted to the use of open wires, for the relatively high static capacity, and the considerable electrical resistance of the small conductors used in these paper cables, although not very detrimental on short lines, would render speech over long distances utterly impracticable under present conditions.

The Switch.

The history of the modern switchboard in its elementary form extends back to the early days of telegraphy, for the most serious problem which has confronted telephone engineers, namely, the ready method of placing a large number of subscribers in rapid and simultaneous intercourse with one another, arose in a minor degree when public telegraphs were first inaugurated. It was obviously impossible to erect wires between every two individual towns throughout any country, and in order to avoid re-transmission of messages at intermediate points, *i.e.*, the writing down of a message received at B, from Station A on one wire, and the sending of it to Station C on another wire, a system was devised by means of which all the circuits in a central office were

terminated on a series of brass bars fixed horizontally on a suitable base, and a second series of similar bars was fixed at right angles to and insulated from the former. The two lots of bars were pierced with holes and provided with pegs, and it was possible to make direct connection between any two of the horizontal bars on which the telegraph circuits were connected by inserting pegs through these into one and the same vertical bar. An old-type switch is exhibited.

This was termed an Umschalter switch, but it gradually fell into disuse, as it was soon found to be more speedy and more economical to transmit the messages by writing them down at one instrument and handing them to another operator to send over the second instrument, rather than to wait till both the circuits were free and ready to be connected through direct.

In the year 1864, the Universal Private Telegraph Company re-introduced the use of these switches for providing connection between subscribers to their private-wire telegraph system so as to place them in direct communication with each other, and what was virtually a telegraph exchange was established by them. The system was subsequently extended by the Post-office to several towns in Great Britain.

On the establishment of the first telephone exchanges in this country the Edison Company started with a switch of the fixed bar and plug type just referred to, whilst the Bell Company introduced a board in which flexible cords, connected to plugs, were used for joining through the circuits. This was the direct progenitor of the modern system of switching.

A telephone switching installation comprises the following apparatus at the Exchange :—

1. *An Indicator*, by means of which the attention of the operator is called when a subscriber desires to communicate.

2. *A Jack*, or switch spring, to which a subscriber's line wires are connected.

3. *Plugs*, for insertion in the jacks, and connecting cords, containing conductors, by means of which connection is established between any two subscribers.

4. *Speaking and Ringing Keys* and other subsidiary apparatus, the use of which appears in the description of a modern switchboard. Specimens of each class of instrument are exhibited.

Each subscriber is, of course, provided with a complete telephone, an electric bell, by means of which he can be called, and some means of actuating the Exchange ind (1) when he desires to communicate.

The operation of telephone switchi small Exchanges is a simple one. Wh shutter of an indicator drops, the op inserts one plug of a connecting cord in corresponding jack, and by depressing a s ing key brings her telephone into the c She ascertains the requirement, insert second plug of the cord into the jack subscriber who is wanted, depresses a ri key which actuates the bell of the second scriber, and the latter, on answering, himself in communication with his c pondent. The apparatus is exhibited. calling up of the Exchange has been effec various ways. In one, the most commo subscribers are provided with a small mag machine, set in motion by a cranked h The turning of this handle drops the Exc indicator. In others, primary batteries been used.

Again, a system known as the "Law "Call wire" system has been tried. I an independent circuit extends from Exchange to a certain number of subscri each call circuit serving from 40 to 60 per It terminates in a telephone at the Exch at which an operator is listening contin To obtain attention a subscriber depres special key on his local telephone, w switches it into the call circuit, and if no is speaking, he makes his wants known another subscriber be using the call ci the former waits his turn. The operato hearing his requirements, makes the nece connections as before, the subscriber rel the "Call key," and his telephone is th cut out of the call circuit and restored t speaking circuit, on which he listens til hears his correspondent answer.

Finally, in the Post-office, a system designed, under the instructions of Mr. Pr by which the removal of the telephone fro suspending hook actuated the indicator a Exchange, and this method has now adopted, and, with certain modificatio which will be described later—it promis become the standard type of working in United States.

When the conversation is finished, reverse operations are performed. If the is originated by ringing, a brief ring is repea and this drops a second indicator sh which is bridged in the connecting cords, which is an instruction to the operator to connect the two circuits. With the "C

n, instructions to sever the connection onveyed on the call wire, and finally, with Post-office system, the restoration of the one to the hook sends an automatic l to the Exchange, which indicates the of the conversation.

ere a special operation is necessary to the severance of a connection, much lty occasionally arises through a sub-r omitting to ring or call off; under conditions, other subscribers who wish eak to either of the two who are l through are told that he is engaged, much discontent and trouble have arisen this cause. The advantage of a system abolishes this special operation and itutes an automatic signal on the hanging the telephone is obvious.

long as Exchanges were of limited size, simple types of switching readily met all ements; but as the number of sub-rs increased, and the switchboards to such dimensions that several operators o be employed, a difficulty arose in g connections between circuits beyond ach of a single operator. This was at net by providing what are termed office on circuits between each operator and all thers; but as the system became more sive, the number of these junctions and fficulty of manipulation increased to such tent as to render this method of working ssible.

meet this difficulty, the multiple board esigned. This board is divided into sec-usually of such a size as to provide space ating three operators, and on each section r the local jacks and indicators of a er of subscribers, varying from 200 up-, according to the average number of dealt with daily. In addition, however, ese local jacks and indicators, all the ts of the whole of the remainder of the ribers to the Exchange are attached to a of jacks fixed on the upper panels of the n, so that each operator is in a position nnect any one of the local subscribers, hose calls she is responsible, directly to ther subscriber on the Exchange. It is, er, evident that before a subscriber con-l to a local section is joined through to ther subscriber, it is necessary to ascer-hat the latter is not connected through at er section of the board to a third sub-r, and this is ascertained in a very in-us manner. On the face of each jack is allic socket, and resting on this socket is one of the springs of the jack itself. These springs and sockets are so connected that on the insertion of a plug into a subscriber's jack, at any section of the board, the socket spring is moved into contact with a stud that connects a battery with the whole of the sockets of the jacks which serve that particular circuit. If a subscriber who is wanted is engaged, the fact is indicated to any operator in the Exchange by a click in her telephone when she touches, with the tip of the plug to which her telephone is for the time being connected, the socket of his jack on her section. If she hears no click, she assumes that the subscriber is disengaged, and connects him through to the calling subscriber.

The early types of multiple boards were extremely costly, and they were subject to many defects which led to the introduction of other systems which were designed to cheapen the service and to improve the working. This again put the advocates of the multiple system on their mettle, with the result that the modern multiple board, as at present manufactured, appears to meet, within its capacity, most of the requirements of a thoroughly efficient telephone system.

I propose to describe briefly the latest form of multiple board, designed by the Western Electric Company, which embodies the most recent developments of American practice.

First, the Post-office system of automatic "calling" by the removal of the telephone from its hook, and automatic "clearing" by the restoration have been adopted: but the progress of modern discovery has placed at the command of telephone experts improved methods of which they have availed themselves. Thus, small electric glow-lamps, worked by relays, have been substituted for the necessarily somewhat cumbersome drop indicators previously used in most Exchanges. These glow-lamps can be placed in any position, vertical or horizontal, and they take up such little space that they can be fixed in the exact localities in which their indications are most readily observed, instead of having to be placed, as in the older boards, at a considerable distance from the jacks and cords with which they are worked. Thus there is no need for hesitation or thought on the part of the operator, whilst trying to connect in her mind a distant signal with the particular operation to be performed, for each lamp indicator is in immediate proximity to the jack or plug, as the case may be, which has to be used.

Under each subscriber's local jack at the

Exchange is placed one of these glow-lamps, which is normally dark, but which acts as the subscriber's calling signal. On the keyboard, and close to each of the connecting cords and plugs, are two similar lamps, the use of which is indicated in the following description of the *modus operandi*:—

On the removal of the subscriber's telephone from the hook the calling lamp immediately under his jack at the Exchange lights, and the operator, without a moment's hesitation, inserts a disengaged plug into the jack. The insertion of this plug extinguishes the "calling lamp," and the operator presses the speaking key forward and simply says, "Number." On receipt of the reply from the calling subscriber the second plug of the pair is used, in the first place, to test the line on the multiple of the subscriber wanted, and then, if the latter be disengaged, for insertion in that subscriber's jack. This action lights the lamp nearest the operator on the keyboard. She reverses the speaking key for a brief interval, and this has the effect of ringing the bell of the subscriber wanted. On his removing the telephone from its hook the front lamp is extinguished, the two subscribers are in correspondence, and the operator is made aware, by the lamps ceasing to glow, of the fact that her work for the time being is complete. Should either subscriber hang up his telephone, as is sometimes done while searching for information, one only of the keyboard lamps lights, but no notice is taken of this, unless it should remain in that position for an undue period. When, however, the conversation is really finished, and both subscribers restore their telephones, both keyboard lamps light, and this is an absolute signal to withdraw the connecting plugs, which action is followed by the extinction of the keyboard lamps. If the subscriber wanted is engaged or fails to answer, the operator says to the originating subscriber, either "busy" or "does not answer," and on the latter restoring his telephone, the lamp on the keyboard furthest from the operator lights, and she withdraws the plug. It will be observed that the speaking in the course of manipulation is reduced to a minimum. When there is nothing to prevent an immediate connection, only one word is uttered by the operator, and this is increased to two when the connection cannot be made. Switches illustrating the series of operations are exhibited in work.

One great advantage of the automatic method of signalling, whether Post-office or Western Electric, is the fact that it mai[n] the line under a constant test; for sh[ould] fault arise on the wires at any time, the si[gnal] give warning of the fact by indicating a c[all] which no answer can be obtained. A lin[eman] is at once dispatched to remedy the [de]fe[ct] before a subscriber has learnt that any[thing] is wrong.

In the Western Electric system als[o] individual primary batteries at each [sub]scriber's office are replaced by central st[orage] batteries at the Exchange, which are used for speaking and signalling purposes. [The] process of replacing primary by seco[ndary] batteries at all large telegraph offices i[n the] country has been in progress for some [time], and these batteries also have been in u[se on] the Department's trunk lines for auto[matic] signalling purposes for a considerable p[eriod], but their use for speaking purposes als[o is a] promising innovation.

Of course, various types of modern s[witch]boards exist, most of which have some a[dvan]tage to recommend their use, but I [have] thought the description of the above [would] have particular interest as being the ou[tcome] of the general experience in the United S[tates], which may be termed the home of teleph[ony].

If the capacity of a multiple switch we[re un]limited, and the telephoning of large [towns] could be effected by concentrating the [whole] of the circuits in one Exchange, the pr[oblem] would be easily met by the use of a swi[tch like] the above, or of some similar type. U[nfortu]nately, the number of subscribers wh[o can] with advantage be served on one swi[tch is] limited, the largest now in use providin[g] for 10,000 subscribers. The limit is [due to] various causes. The range of an ope[rator's] reach is not great, and it is obviously u[seless] to extend the multiple jacks beyond her [reach]. There is also a limit to reduction which [can be] effected in the size of jacks, so that it [is im]possible to crowd more than a certain n[umber] within a given space. There are also [other] objections to which specific reference ne[ed not] be made, but the result is that to dea[l with] a large number of subscribers it is nec[essary] to establish several Exchanges, and the[se are] connected together by junction circuits. [These] circuits are virtually the equivalent, in a [certain] degree, of the trunk circuits connectin[g the] larger cities and towns, and they ar[e now] almost universally worked by means of [auto]matic signals, but a detailed description [of the] methods in use would scarcely have su[fficient] interest to justify further explanation her[e].

vill be interesting to quote certain figures ve to the Central Exchange belonging to rench Government in Paris.

s at present fitted for 15,000 subscribers, to provide for this number no less than oo jacks are joined up. To connect these n the interior of the building, there are 118 of 40-wire cable, giving an aggregate of miles of wire in the switch-room. These s are cut and jointed to the jacks at in- ls of about 12 inches, and this has in- d the making of 2,500,000 soldered joints. mention these figures because it has ne the fashion to under-estimate the work nstructing a modern telephone system.

take an analogy. It is a simple matter ovide the catering for a single establish- , but there are few problems of greater itude than the provisioning of an army of, 100,000 men. In the same way, any ber-electrician can run up a few score and connect them to a switch, but when vires grow from scores to thousands, and of thousands, spread over an area of some hundreds of square miles, the problem becomes as intricate as that involved in any other type of heavy electrical engineering.

The telephone trunk service of Great Britain, in other words, the system which provides intercommunication between the principal towns in the country, was fully described in a paper I had the honour of reading before the Institution of Electrical Engineers, in November, 1896, and there has been no material modification in the methods then described. On the 31st March, 1898, the Post-office plant comprised 56,373 miles of wire at work, and in course of construction, and 269 towns were connected with trunk circuits, by means of which any one of them could be placed in direct connection with any of the others. The system is being rapidly extended.

The following Table, which shows the mileage of the telegraphic and telephonic systems throughout the world at the end of the year 1898, will be of interest. It is compiled from official documents supplied to the Bureau International de Berne.

ROXIMATE MILEAGE OF THE TELEGRAPHIC AND TELEPHONIC SYSTEMS OF THE WORLD, JANUARY, 1899.

	Lines.				Wire.			
	Telegraph Lines.		Telephone Lines of States and Private Companies.	Totals.	Telegraph Lines.		Telephone Lines of States and Private Companies.	Totals.
	State Administrations and Private Companies.	Railway Companies.			State Administrations and Private Companies	Railway Companies.		
untries subject to the rnational Telegraphic vention :—	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
ean	490,200	179,570	169,300	839,070	1,604,300	623,200	852,800	3,080,300
European	167,300	64,620	14,290	246,410	406,100	205,300	119,230	730,630
Countries not subject to Convention :—								
America—								
Vestern Union Co. ..	233,000	..	..	233,000	1,003,400	..	..	1,003,400
ostal Telegraph Co...	18,640	..	..	18,640	108,730	..	..	108,730
ther offices	..	248,500	186,400	434,900	..	745,600	2,175,000	2,920,600
America	15,533	9,300	3,107	27,940	29,820	27,960	31,070	88,850
, Asia, and Australia	24,853	27,950	9,320	62,133	74,560	83,880	24,850	183,290
Submarine Cable panies	167,800	..	..	167,800	169,600	..	..	169,600
	1,117,526	529,950	382,417	2,029,893	3,396,510	1,685,940	3,202,950	8,285,400

nally, I may venture to say that it is st impossible to predict the future of the hone. There is room for unlimited growth, and great as have been the developments of the ordinary methods of telegraphy, they are probably destined to be entirely eclipsed by

the telephone which may before long be the principal channel through which both business and social intercourse of the country will be carried on.

DISCUSSION.

The CHAIRMAN said this had been an absolutelypractical paper; there was nothing in it controversial, and it had shown very well that the chief characteristic of the telephone was its simplicity. When he brought the first telephone to this country from America, in 1877, and described it to the British Association at Plymouth, he summed up the whole matter in two words, which had been repeated over and over again, by saying that its chief merit was its "ridiculous simplicity." Another point worthy of notice was this; that however much the use of the telephone in this country had been retarded, there had been no obstacle to the improvement in its working; nearly all the steps in its progress had emanated from this country, and other countries, particularly America, had flattered them most sincerely by copying them in many particulars. Still, they could not blink the fact that for some reason the telephone in England was eminently unpopular. Why this was so he could not say; perhaps some light might be thrown on the question in the discussion, but he might suggest that one great reason was ignorance—ignorance of the construction and working of the telephone, of the appliances used to make it serviceable, and of the intricate and exacting duties which had to be discharged by the operators, who were generally, if not universally, young ladies. Mr. Gavey was a most experienced experimenter; for twenty-one years he had been his (the Chairman's) right hand, and had experimented with telegraphs and telephones in every form and shape, and yet, when he came to read his own paper, and to show the operations of a simple instrument, he had partially failed. If this were so, surely some consideration ought to be shown to those young ladies who were doing their very best to serve the public, but who, he feared, had often to listen to very impolite remarks. Mr. Gavey had not mentioned one interesting fact, viz., that in consequence of improvements originated by the Post-office, and now adopted all over the world, the use of automatic signalling had put an end to the use of that phrase which used to be so frequent and so annoying—"Have you finished?" Those in London who used the telephone a good deal, were still sometimes vexed by this question being asked, but when the automatic system would be introduced they would hear it no more. He could not help calling special attention to the immense growth of the telephone system. It was something to have lived in an age when they had seen the growth of electricity from childhood to manhood. As he had already said, he brought the first telephone across the Atlantic; he saw it before a single Exchange existed in A[merica] for there were not more than two or thr[ee] cuits at work when he was sent over [by the] Po tmaster-General of the day to inquire in[to the] merits of this instrument. That was only i[n] and now there were nearly 4,000,000 miles [of wire] employed for telephones, and the total num[ber of] miles of wire used in telegraphy was about 8,0[00,000.] Even in one single Exchange in Paris, 2,[000,000] joints had to be made to complete the work. [This] all showed that those who carried out this w[ork for] the convenience of the public should receiv[e] consideration. An engineer had been define[d as] one who applied the great forces of nature [to the] wants and wishes of mankind, and he vent[ured to] think that there was no branch of engineering [which] had done more to make life comfortable an[d] than that connected with electric telegrap[hs and] telephones.

Mr. J. E. KINGSBURY said he had liste[ned to] the paper with very much pleasure, an[d was] pleased to note the remark that the work con[nected] with telephones was entitled to stand on a lev[el with] any other branch of electric engineering. The [extent] to which they were indebted to American contri[butions] had been referred to, but he might point ou[t that] America was also indebted to England in [many] points. It was within his knowledge that th[e] work between London and Birmingham had att[racted] a good deal of attention from American en[gineers] who had carefully investigated it, and who, [he was] sure, would be willing to give full credit [to the] originators of the system. This cable work [was of] quite a pioneer class, and would probably alt[er] change the conditions of long line working.

Mr. DANE SINCLAIR said all who were f[amiliar] with telephone work must have listened to the [paper] with great pleasure. To him it had been [a] treat, because the exposition had been so [simple] and yet so complete, and he must congr[atulate] both the author and his audience. Mr. Ga[vey had] led them from theory to practice, and from the [old] practise to the very latest developments. Afte[r deal]ing shortly with the instrument itself, he came [to the] part which required most attention, the sw[itch] arrangements, and on that matter he had b[rought] them thoroughly up to date. As the Chairm[an had] said, the arrangements seemed very simp[le, as] simple as the instrument before them ap[peared;] when they thought of what a large Exchange i[n] or London is like, they would recognise th[at what] was in principle simple enough, must become ext[remely] intricate. Last year he was in the States, a[nd saw] this new system of lamps and a common batte[ry, and] was much taken with it, but was not sure that [all the] points had been considered which were neces[sary to] make it suitable to a place like London. [For] instance, if one of the subscribers had two o[r]

hones in his office, how would you ensure that the one was put in circuit when he was called up e Exchange? Apart from this difficulty, he ht the lamp was a great advance on the more anical systems previously in use. There was ng to make it excessively costly, and he had no that those who had charge of the telephone ns would gladly introduce anything which ren- the service more speedy and efficient.

. STANLEY FLINT said he would endeavour to ome answer to the question of the Chairman, he telephone was unpopular. They had been an ideal system, but what they suffered from ndon was a very inefficient system. As a iber for some years, he might say that he often a difficulty in getting in connection with other ibers, and was inconvenienced by being cut off middle of a conversation. If the system were efficient, there would be more subscribers, the charges were very high—much higher n most Continental countries. The constant e you finished?" was very annoying, but it was orse to be suddenly cut off even if you answered '

A. O. GRANGER said he was a user of the tele- on the other side of the water, and should be glad w if any explanation could be given of the different which prevailed in different places. He used ephone in Canada, and in two places in the States. In Philadelphia they paid 150 dollars for one telephone; in Montreal 40 dollars; and rlesville, a little town in Georgia, of under nhabitants, they only paid 18 dollars. Gene- hen an article came largely into use it was ned, but in the case of telephones the reverse to be the case, the highest rate being charged argest towns.

CHAIRMAN said he would leave Mr. Gavey, d recently visited the States, to reply to the estion if he could, but with regard to the s objection as to the inefficiency of the system ation in London, it was only right to point out e instrument exhibited that evening was the test development, which had only been per- within the last few months, and it was quite ible for a private company, or even a Govern- epartment, to replace or renew their apparatus ter year to meet the wishes of an exacting He might say that of all the systems he had inspected, the very worst—from an expert's of view—was that adopted by the German ment in Berlin; and yet, in spite of that, there town in the world where telephony was so . He did not say the London system was though he had inspected Exchanges in London vere absolutely perfect according to the know- nd experience of that time, and yet the public ssatisfied, and said the system was inefficient. He had over and over again pointed out that the chief source of inefficiency in the telephone service lay with the users, and it was the same with nearly all branches of the public service, such as telegraphs and railways. If an exacting public did not get everything abso- lutely up to date, they were dissatisfied and grumbled. Anyone who was dissatisfied should not write to the papers and complain, but go the nearest Exchange and ask to be shown the working of the system; the more they understood it the better would they be able to use their own telephone, and the better they would be pleased with the service. He would con- clude by proposing a hearty vote of thanks to Mr. Gavey.

The vote of thanks having been carried unanim- ously,

MR. GAVEY, in reply, said the newly designed method of automatic working which he had exhibited had only recently been introduced, and at present the demand on the manufacturers was so great that, huge as their factories were in New York and Chicago, they were doubling them in size in order to meet the American demand alone. At the large Exchanges they were fitting them up as rapidly as possible, and he believed in this country the National Telephone Company would soon have one fitted up in Bristol. With reference to Mr. Sinclair's question, curiously enough, there was more difficulty where a subscriber had two telephones in his office than if he had twenty. In many of the large buildings which were so frequent in American cities there was a private wire exchange in the structure itself, to which all the offices were connected. In St. Louis, when a company erected a large building they provided a private wire ex- change, and put a telephone in every office, the use of which was included in the rent. Every tenant could communicate free of charge with everybody in the building. That private exchange was connected with the Central Exchange, and those who wanted to speak through the Central Exchange, could do so on paying a toll for each call. With a system of that kind, the signalling was very simple; junction circuits were pro- vided between the private wire exchange and the Central Exchange. Where a subscriber had two tele- phones alone, he believed a method of signalling at both stations from the central batteries was now being evolved by the inventors, and he was told there was every hope of arriving at a satisfactory solution of the problem shortly. With reference to the question of rates in the United States and Canada respectively, he was not prepared to give a very definite reply. In the United States, at all events, the master patents which controlled the telephones were in the hands of one large company, and until the last few years it was the practice to charge "flat rates," which meant the same system as was in vogue here—an annual payment which gave the right to un- limited user. For various reasons very high flat rates were charged, and the result was that the number of

subscribers was somewhat limited, but in order to meet the demand of smaller users the various companies in most of the cities introduced what was termed the toll system. Under that they charged a moderate rate—say £20—per annum, which gave the right to six or seven hundred conversations, with an extra charge for each call beyond that number. The result of that was very wonderful. He was told that one company in New York alone had 6,000 additional subscribers in one year. He should imagine that in all probability the charge in Philadelphia was a "flat rate," and in Charlesville a "toll rate."

Mr. GRANGER said it was a "flat rate" there also.

Mr. GAVEY said in that case he could not explain how such a difference arose.

Miscellaneous.

TECHNICAL EDUCATION IN GERMANY.

German merchants and manufacturers are alive to the importance of increasing the efficiency of the mechanics and artisans, and of improving the quality of their goods. According to the United States Consul at Hanover, they appear to be resolved that "Made in Germany" shall no longer pass as a term of opprobrium, but be a synonym of excellent materials and good workmanship. A meeting took place recently in Hanover, which is likely to exercise a very important influence in this direction. It was in the nature of a conference, under Governmental sanction and direction, to discuss German trade and manufacturing interests, and to devise plans for their extension and improvement. It was held at the instance of the Prussian Minister of Trade and Commerce, and was presided over by the Oberregierungs President of the Province of Hanover, Count Stolberg. Representatives of the Government from Berlin, the highest officials of the Hanoverian provincial and municipal administrations, leading manufacturers and business men, delegates from the Chamber of Commerce, the manual training and artistic trade schools, and from the working men's trade unions, attended and took part in the deliberations. As a result of the conference, it was unanimously resolved:—1. To establish at once in the city of Hanover advanced lecture courses, in which artisans and apprentices in all trades shall have an opportunity to complete their mechanical education, and be instructed by experts how to install and manage a model workshop, and work and use machines and tools to the greatest advantage. Instruction will also be given in book-keeping, the making and rendering of accounts, the making of estimates of the cost of work and materials, how to conduct business correspondence, drawing, and other practical branches. 2. The supervision and control of the said lecture courses shall be under the direction of a commission composed of representatives from the Imperial, provincial, and municipal administrations, the Chamber of Commerce, the manual and art schools, and from the trade unions. 3. The first course of lectures will be for cabinet-makers, locksmiths, shoemakers, and tailors. Those for other trades will follow. 4. A fee for tuition will be exacted from mechanics able to pay, but those unable to pay will be instructed free. Funds for the payment of the tuition of the poor will be provided by the Hanover provincial and municipal Governments. 5. Only mechanics and apprentices will be admitted to the classes whose theoretical and practical knowledge is such as to give promise of success as students. The Commission has power in all cases to decide as to qualification of applicants for admission. 6. Teachers are to be selected by the Commission, and confirmed by the Minister of Trade and Commerce. 7. The cost of the establishment and maintenance of the lectures is to be supplied by the General Government, and that of the province and city of Hanover, together with the trades unions, the Chamber of Commerce, and others interested therein. 8. It is further intended that great care shall be used in teaching apprentices how to obtain the most practical advantages from the knowledge obtained by them in the classes. To this end, the creation of working-men's co-operative societies is to be urged. 9. A permanent exhibition of all power machines and tools used in the small trades is to be established in the Gewerte Halle (Industrial Hall) in Hanover. The machines exhibited there are to be worked by competent mechanics, who, on request, will exhibit their uses and management to all inquirers. In connection with the machine exhibition, there will also be established an exhibition of sample products, in process of manufacture, as well as finished. 10. In order to enable small manufacturers and tradesmen to purchase their raw materials at wholesale prices, and to facilitate the sale of their products, the formation of co-operative stores is to be encouraged. Consul Anderson has been informed that the establishment of these courses of lectures to mechanics is the initial move in a general plan to be in all the main labour centres of Germany, dependent upon the success of this experiment.

Obituary.

THOMAS ALLEN REED.—Mr. Reed, the well-known shorthand writer and reporter, who had held the office of Examiner for Shorthand in the Society of Arts Examinations since 1888, died on the 29th March, at his residence, Rusholme, Surbiton. He was born at Watchet, Somersetshire, on April 6th,

1826, and in early life was associated with the late Sir Isaac Pitman, the inventor of phonography, in the promulgation of that system of shorthand. Fifty years ago, Mr. Reed established an agency called the Metropolitan Reporting Agency, for the purpose of supplying the Press with reports of all public proceedings, and he presided over it until his last illness. He was a past President of the Shorthand Society, and the chief organiser and chairman of the committee of the first International Shorthand Congress, held in London in 1887, in celebration of the tercentenary of the art. He was the author of several works on shorthand, and adapted phonography to the French language, publishing a work on the subject in 1882.

General Notes.

The Brewing Industry in Germany.—According to a German trade review, it appears that during the year 1897-98, in the 8,055 breweries of Germany proper, exclusive of Bavaria, Wurtemberg, Baden, and Alsace-Lorraine, there were brewed altogether 916,000,000 gallons of beer, the revenue derived from the taxation of which amounted to £1,869,000. In Bavaria the 6,364 breweries produced a total of 351,000,000 gallons, on which was paid £1,780,000. In Wurtemberg the 6,285 breweries produced 90,000,000 gallons, and paid into the exchequer £467,000. In Baden the 946 breweries, with their output of 60,000,000 gallons, paid a Government tax of £326,000. In Alsace-Lorraine the 127 breweries showed an output of 21,230,000 gallons, and paid into the exchequer £157,000.

Wood Paving.—The *Vie Scientifique* reports that trials are being made in Paris with the kari wood for street paving, instead of the pitch pine or Norwegian fir generally employed. Kari is a hard and heavy wood, of close grain and greasy appearance, that has considerable analogy with teak, while, like that wood, it withstands damp and wear. Resembling mahogany in colour, though of far closer grain, kari flourishes in tropical regions, and large quantities are found in the forests of Australia. It is brought to Europe at the bottom of vessels' holds as ballast, and in Paris it is sold, sawn into blocks ready for laying, at the rate of 124 francs per cubic metre (£3 16s. 3½d. per cubic yard).

Electrical Exhibition at Brussels.—An exhibition of the domestic applications of electricity is announced to open on 1st June this year, in the new Hôtel des Téléphones, Brussels, and to remain open at least a month, but not longer than six weeks. Not only Belgians, but all who have a representative in Belgium are free to exhibit, and the electric current will be supplied gratis by the Brussels municipality. The exhibition, which is due to the initiative of M. Banneux, Director of the Telegraph Administration, will be held under the auspices of the Belgian Society of Electricians, and under the patronage of the King of the Belgians, while Prince Albert of Belgium is Honorary President. Further particulars may be obtained from the Secretary of the Executive Committee, 18, Rue Melsens, Brussels.

Philadelphia Commercial Exhibition.—The Department of Science and Art has received, through the Foreign Office, from Her Majesty's Ambassador at Washington, a copy of a joint resolution by the Senate and House of Representatives of the United States of America, to the following effect, respecting the Commercial Exhibition to be held at Philadelphia this year. Exhibitors will not be restricted by the Acts of Congress, prohibiting the importation of foreigners, from bringing into the United States, under contract, foreign labourers for the purpose of preparing for and making their exhibits under the regulations prescribed, provided that no alien shall enter the United States under contract to perform labour except by express permission, naming such alien, of the Secretary of the Treasury; and any such alien who may remain in the United States for more than three months after the close of the Exhibition shall be subject to the penalties applicable to aliens coming in violation of the alien contract-labour law.

Wine and Cider Production in France.—The yield of wines in France in 1898 amounted to 710,211,898 gallons, being a decrease of 1,503,986 gallons as compared with 1897. The average yield per hectare (2½ acres) from the 4,266,282 acres of vines in the various departments of France amounted to 418 gallons, which is 22 gallons less than in 1897, and inferior by 154 gallons to the yield in 1896. The yield in the department of the Herault averaged nearly 800 gallons (of a value of about 9d. per gallon), and in the department of the Gironde to only 366 gallons (of a value of about 1s. 6d. per gallon), while in the Champagne country, the average yield was 570 gallons, valued at about 2s. 11d. per gallon. The production of wine from dried raisins amounted to 2,835,470 gallons, as compared with 9,931,284 gallons in 1897. The yield of cider in 1898 amounted to 234,023,592 gallons, while the yield for the previous ten years averaged 289,485,152 gallons. Practically, all the cider is consumed in the country, as the quantity exported in 1898 amounted to only 393,426 gallons. There is, however, a small export trade in cider apples. Last year, owing to the bad crop, it amounted to only £6,622, which is £31,757 less than in 1897.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

April 19.—"London's Water Supply." By Walter Hunter, M.Inst.C.E. Wm. Whitaker, F.G.S., F.R.S., will preside.

April 26.—"Coal Supplies." By T. Forster Brown. W. Boyd Dawkins, F.R.S., will preside.

May 3.—"Aerial Telegraphy." By W. H. Preece, C.B., F.R.S.

May 10.—"Fruit Growing in Kent." By George Bunyard. Sir George Birdwood, K.C.I.E., C.S.I., will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

April 27.—"Judicial Reform in Egypt." By Sir John Scott, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive. The Lord Chief Justice of England, G.C.M.G., will preside.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

April 18.—"Inlaying." By Stephen Webb. John Sparkes will preside.

May 2.—"Maiolica." By William Burton.

May 16.—"The Artistic Treatment of Picture Frames." By J. Hunter Donaldson.

May 30.—"The Revival of Tradesmen's Signs." By J. Starkie Gardner, F.G.S.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Prof. Henry R. Procter, F.I.C., "Leather Manufacture." Four Lectures.

Lecture I.—April 17.

Primitive methods - Difficulties of investigation—Sources of raw material—Methods of curing—Anatomical structure of skin—Arrangement of hair-pores—Chemical character of skin and epidermis—Manufacture of gelatine—Soaking and softening of hides and skins preparatory to tanning.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Henry R. Procter, "Leather Manufacture." (Lecture I.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. G. Reid, "Sanitary Appliances."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. Hull, "Sub-oceanic Terraces and River Valleys."

Tuesday, April 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Stephen Webb, "Inlaying."

Royal Institution, Albemarle-street W., 3 p.m. Prof. J. Cossar Ewart, "Zebras and Zebra-Hybrids." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. James Murray Dobson, "Buenos Aires Harbour Works."

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5 p.m. Mr. George Martineau, "The Statistical Aspect of the Sugar Question."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Photo-mechanical Meeting. "Apparatus for Half-tone Process Work."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. C. W. Andrews, "The Extinct Birds of Patagonia.—I. The Skull and Skeleton of *Phororhacos inflatus*, Ameghino." 2. Staff-Surgeon P. W. Bassett-Smith, "A Systematic Description of Parasitic Copepoda found on Fishes, with an Enumeration of the known Species." 3. Mr. W. E. de Winton, "The Species of *Canidæ* found on the Continent of Africa."

Asiatic, 22, Albemarle-street, W. 4 p.m.

Wednesday, April 19...SOCIETY OF ARTS, John-street, W.C., 8 p.m. Mr. Walter Hunter, "London's Water Supply."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. Henry Mellish, "Soil Temperature." 2. Major-Gen. H. Schaw, "Some Phenomena connected with the Vertical Circulation of the Atmosphere."

Microscopical, 20, Hanover-square, W., 8 p.m. Prof. Lionel S. Beale, "The Bioplasm of Man and the Higher Animals, and its Influence in Tissue Formation, Action, and Metabolism — a Microscopical Study."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Mr. J. W. Gordon, "King James' Book of Bounty." 2. Mr. J. C. Chapman, "Some Aspects of Disconformity and the Judicial Functions of the Patent-office in regard to same, and other matters."

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Presidential Address. 2. Mr. C. W. Merrill, "Notes on the Alleged Shortage in Cyanide Bullion." 3. Mr. Henry F. Collins, "The Chemical Reactions involved in the Amalgamation of Silver Ores."

Thursday, April 20.. Royal, Burlington-house, W., 8 p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. W. H. Pearson, "The Botany of the Ceylon Patanas." 2. Prof. A. J. Anderson, "Imitation as a source of Anomalies." 3. Rev. O. Pickard Cambridge, "List of British and Irish Spiders."

Chemical, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. W. Clarke, "Details of Plumbers' Work."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Atmosphere." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (James Forrest Lecture.) Prof. J. A. Ewing, "Magnetism."

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Friday, April 14..Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Dr. F. W. Pott, "Structure of the Brain in Relation of its Functions."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Chemical Society's Rooms, Burlington-house, 5 p.m. 1. Mr. C. S. Whitehead, "The Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside." 2. Mr. R. A. Lehfeldt, "Demonstration of Richards's Method of Standardising Thermometers."

Saturday, April 22..Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Louis Dyer, "Machiavelli." (Lecture II.)

Journal of the Society of Arts.

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FRIDAY, APRIL 21, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Professor Henry R. Procter, F.I.C., delivered the first lecture of his course on "Leather Manufacture," on Monday evening, 17th instant.

The lectures will be published in the *Journal* during the summer recess.

UNION OF INSTITUTIONS.

The following Institution has been received into union with the Society since the last announcement:—

St. Bride Foundation Institute, Bride-lane, Fleet-street, E.C.

APPLIED ART SECTION.

Tuesday, April 19, 1899; John Sparkes in the chair. The paper read was on "Intarsia or Inlaying," by Stephen Webb.

The paper and report of the discussion will be printed in the next number of the *Journal.*

Proceedings of the Society.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 19, 1899; William Whitaker, P.G.S., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Greene, Frank Arnold, 22, Martin's-lane, Cannon-street, E.C.

Hall, John Slocombe, 45, Chatsworth-road, Brondesbury, N.W.

Molloy, Harry J., care of Messrs. W. Watson and Co., 7, Waterloo-place, S.W.

Pakenham-Mahon, Captain Henry, D.L., 35, St. George's-road, Eccelston-square, S.W., and Stokestown, Ireland.

Wiseman, William Thomas, Cromwell-house, 160, Stockwell-park-road, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Lehmann, Charles Theodore, Moorside, Ealing, W.

Locke, Cyril L. C., St. Neots, Eversley, Winchfield.

Phillips, Lionel, 33, Grosvenor-square, W.

Piper, John Edwin, LL.B., 16, Middleton-road, New Wandsworth, S.W.

Polak, Joseph Henry, 28, Grosvenor-road, Highbury New-park, N.

Reid, Arthur H., P.O. Box 120, Cape Town, South Africa.

Whittow, Thomas, 35, Oxford-gardens, W.

The paper read was—

LONDON WATER SUPPLY.

By Walter Hunter, M.Inst.C.E.

A constant and plentiful supply of pure water is necessary for the sustenance, health, and comfort of every community. The water supply of large cities has consequently demanded the attention of the most civilised nations which have existed in the past ages of the world. Notably, the Romans are renowned for the aqueducts which they constructed for the supply of water centuries ago, and water for irrigation and other purposes has for ages been stored in tanks by the natives of India.

The history of water supply, as practised in different parts of the world, would be an interesting and fascinating theme to pursue, but the water supply of London, which I have been asked by the Council of the Society of Arts to describe, forms in itself so large a subject that I feel it necessary, without further preface, to enter upon the special subject which brings us together to-night.

It is, however, interesting to note that for two centuries after the Conquest, London obtained a sufficient supply of water partly from the rivers and streams which passed through it, and partly from wells sunk into the sands and gravels above the London Clay. Holywell, Clerk's Well (Clerkenwell), and St. Clement's Well (near Clement's-inn), are mentioned by Fitzstephen as those "of most note." In 1236, the Magistrates purchased from Gilbert Sandford the liberty to convey the waters of the Tyburn from Paddington in leaden pipes to the City, and a great conduit of lead, castel-

lated with stone, was begun in Eastcheap in 1285. Various other conduits were built in the 14th and 15th centuries, some for the water of the Thames, from which also the inhabitants were supplied by the City Company of Water-bearers, who brought it in leather panniers slung on horses.

In 1582, a great step in advance was taken by Peter Moris, a Dutchman, who erected a *forcier*, on an arch of London-bridge, to convey the Thames water into the houses in the east end of the City as far as Gracechurch-street; in 1594, another was erected near Broken Wharf for West Cheap, Fleet-street, and the district round St. Paul's; and in 1610, a third at Aldersgate, without the gate. Moris, who obtained the lease of an arch of London-bridge for 500 years, at a rental of 10s. per annum, and two years later the use of another arch, erected for his purpose very ingenious machinery; and the works continued until 1701 in possession of his family, who, after amassing large wealth, sold the lease to a company for £30,000.

This company ultimately occupied four arches, and continued until 1822, when the works were removed just before the demolition of old London-bridge, and the property was sold to the New River Company.

Dr. Sisley, in his interesting and accurate book upon the London water supply, recently published, gives an excellent account of the early history of the supply, and describes the state of the London-bridge Waterworks Company in the beginning of this century, as follows:—

"The quantity of water supplied by the Company in 1610 was estimated at something between 3,000,000 and 4,000,000 gallons daily, and the water-wheels worked for about twenty hours each day. When the tide was very low less water was raised by water-power, and the necessary quantity was made up by working a steam-engine. The superintendent of the Company gave a somewhat depressing account of the state of business in the year 1821. They had at that time a very "strong enemy" against them, which had taken away many of their customers. 'They were in a state of pauperism, and much to be pitied.' The 'strong enemy' was the New River Company, which had the power of raising water higher than the London-bridge Company could possibly do. The new fashion of building high houses was disastrous to the Company, because cisterns and water-closets were placed at an unreasonable distance above the ground in the new buildings. The distributing pipes used by the Company were made of wood, and they had not money enough to replace them by iron ones. They were unable to supply the water at a higher level than the second story of a house. The superintendent of the Company would not admit that the water supplied was of a bad quality, and he said that in many instances distillers took it in preference to any other, but he said he never thought of drinking it in the condition in which it was supplied. The ebb tides, he admitted, brought down a considerable quantity of soil from the rivers which ran into the Thames, and the water was frequently foul, but after it had stood in a cistern for twenty-four hours it became 'finer than any other water that could be produced.' For his own supply the superintendent had two large cisterns, and by drawing out the water alternately every other day he had 'as clear water as could be imagined.' The rates charged for supplying the tenants of the London-bridge Waterworks varied, according to the amount supplied, from a minimum of less than £1 to a maximum of over £20 per annum. The total number of customers was a little over 10,000, and sixty-eight public buildings were supplied. The method of arranging as to the price charged to customers was that the surveyor first examined the premises closely, and reported to the superintendent what he thought the consumption was likely to be, and the size of the service-pipe. The price was then fixed, and if in the course of time it was found that the consumption was more or less than had been estimated, an abatement or increase in the sum charged was made, according to the circumstances of the case. Brewers, stable-keepers, and some other tradesmen were subject to an extra charge. The amount of water considered necessary for a daily supply to a house was one butt, and any quantity above that was considered 'extra service.'

"With regard to the ultimate failure of the London-bridge Waterworks, it may be said to have been due not so much to complaints as to the quality of the water supplied as to the fact that the New River Company were able to supply water at a higher pressure, which enabled them to force it to the upper storeys of the London houses."

The Corporation of the City of London obtained an Act to convey water from Hertfordshire to the City, in 1606, and a supplemental Act in the following year, but failed to avail themselves of their provisions. The works contemplated under these Acts, were undertaken in 1609 by Hugh Myddelton, who, when his funds became exhausted in 1612, received the necessary money from King James I., on condition that he should share in the profits. This was the commencement of the prosperous enterprise since known as the New River Company. The Chelsea Company was founded in 1721, the Vauxhall Company in 1805, the West Middlesex and East London Companies in 1806, the Kent in 1810, the Grand Junction in 1811, and the Southwark in 1822.

The history of all these companies reveals

the fact that the municipal and local authorities were unwilling to undertake the risk of supplying London with water, leaving it to be carried out by private enterprise, which in this way, as in so many other ways, has proved itself to be the great factor in promoting the material interests of the country. This fact is apt to be forgotten or hidden from view by the apostles of the new school of Socialistic doctrinaires, who seek to repress individuality and depreciate self-interest, which, when properly regulated, has nevertheless been one of the most powerful motives for the advancement of mankind.

Having thus briefly traced the history of the London water supply, let us turn to the consideration of its extent in the present day. The subject appears to divide itself naturally into six heads :—

1. The area and population to be supplied.
2. The quantity of water supplied.
3. The sources of supply and the quantity taken from each source.
4. The works for the storage, filtration, and distribution of the water by the companies for the supply of their several districts.
5. The quality of the water.
6. The supply in the future.

1.—The Area and Population Supplied, or which must Eventually be Supplied.

The area supplied by the eight metropolitan water companies under their Parliamentary powers is generally known under the name of Water London, and has a total area of 620 square miles. It extends from Amwell (near Hertford) in the north, to Croydon in the south, and from Hampton in the west, to Ilford in the east. Its population in 1891 was about 5,237,000, and is now estimated at about 5,800,000, having increased from 958,863 at the beginning of the century.

Water London contains within it the administrative County of London, and is coextensive with the area called Registration London by the General Register office with the addition of the hamlet of Penge.

Greater London is the area included within the Metropolitan and City Police districts. It includes all parishes wholly situate within a circle of 15 miles radius from Charing-cross, and all parishes of which any part is included within a circle of 12 miles radius from the same centre. Its total area is 701 square miles, and its population in 1891 was 5,633,332. It is this area and population, with the addition of the area and population of Water London which lies outside it, which Lord Balfour's Commission took into consideration when framing their valuable and exhaustive report in 1892-3. But perhaps the best idea of the gigantic problem of the London Water Supply can be obtained by the knowledge that the population to be supplied is equal to the aggregate population of the following cities and towns in the United Kingdom—viz., Glasgow, Birmingham, Liverpool, Manchester, Salford, Edinburgh, Dublin, Belfast, Leeds, Sheffield, Aberdeen, Dundee, Bath, Bristol, Southampton, Northampton, Nottingham, Newcastle, Bradford, Cardiff, Swansea, Blackburn, Halifax, Derby, and Brighton. Such a fact speaks for itself without comment.

The supply to Water London is given mainly by the eight metropolitan water companies, viz., the Chelsea, East London, Grand Junction, Lambeth, Kent, New River, Southwark and Vauxhall, and West Middlesex Companies.

In addition, outside the Parliamentary districts of these companies and wholly or partly within the area of greater London, the following ten water companies and local authorities give supplies :—

The Barnet District Gas and Water Company.
The Central Middlesex Water Company (Alperton and Sudbury).
The Colne Valley Company.
The East Surrey Company.
The Epsom Local Board.
The Rickmansworth Company.
The South West Suburban Company.
The Sutton Company.
The Uxbridge Local Board.
The West Surrey Company.

Such being the area and population supplied we proceed to consider the quantity of water supplied.

2.—The Quantity of Water Supplied.

As the quantity supplied by these smaller bodies was estimated by Mr. Balfour's Commission to be not more than 10,000,000 gallons daily, we propose to neglect them and to confine our attention to the eight metropolitan water companies.

The average daily quantity of water supplied in 1897 by the eight metropolitan water companies, the population supplied, and the average daily supply per head, are given in the following Table :—

Company.	Population supplied.	Average daily supply (in gallons).	Average daily supply (per head).	Sources.
East London	1,261,732	41,036,906	32 52	Lea, Thames, and wells.
New River	1,176,363	35,974,488	30·58	Lea, wells, and springs.
Southwark and Vauxhall	809,320	33,767,401	41·72	Thames and wells.
Lambeth	666,981	23,688,305	35·51	Thames.
West Middlesex	601,509	20,337,019	41·72	,,
Kent	512,412	15,482,056	29·94	Wells.
Grand Junction	398,396	19,532,580	49·03	Thames.
Chelsea	276,691	12,283,789	44·32	,,
Totals	5,703,404	202,102,544	35·43	———

Total supply, 1897—73,767,428,465 gallons.

3.—The Sources of Supply.

The sources of supply are:—(a) The Thames and the gravel beds adjacent to the river; (b) The Lea and springs in the Lea Valley; (c) Thirty-two wells in the chalk formation.

In 1897 the average daily quantities supplied from these sources were as follows:—

	Gallons.	Per-centage of whole supply.
From the Thames	112,178,641	55·51
From the Lea	55,292,863	27·36
From springs and wells	34,488,016	17·06
Hampstead and Highgate ponds (non-domestic).	143,024	0·07
Total	202,102,544	100·00

Having thus given the leading facts of the water supply of London, we proceed to the consideration of our fourth division of the subject.

4.—The Districts of the Several Companies and the arrangement of their Works for Storage, Filtration, and Distribution.

The New River Company.

The New River company was incorporated by Royal Charter in the reign of King James I, the Charter prohibiting any interference with the New River, or the bringing to the cities of London and Westminster and the borough of Southwark, water from any place whatsoever without the license of the New River Company. The powers of the company have since been altered by Acts of Parliament passed at different times.

The company's district of supply includes the City of London (with a few exceptions in Bishopsgate and Aldgate, supplied by East London Company), Edmonton, Enfield, Hornsey, Tottenham, in Middlesex; and, in Hertfordshire, Broxbourne, Cheshunt, Great and Little Amwell, Hoddesdon, St. Margarets, Ware, Wormley, and St. John's without the Borough of Hertford.

It should, however, be noted that in Middlesex the District Councils of Enfield and Tottenham have independent sources of supply, while very few supplies are given to the parishes in the county of Hertford. This district is coloured red upon the cartoon, which clearly shows its general extent and boundaries.

The average population supplied in 1897 was 1,176,363, the average daily supply being 35,974,488 gallons.

The New River Company derive their principal supply from the Lea, the intake being situated between Hertford and Ware Locks. Under the River Lea Water Act of 1855 a quantity of about 5,400,000 gallons daily is reserved for the navigation, and as much as be necessary in addition to keep up the head of water in each level of the river.

The New River Company have a preferential right to take 22,500,000, and the East London Company to take 22,500,000. When these demands are satisfied the two companies are empowered *pari passu* to take all the remaining flow of the stream. A balance gauge has been constructed at the intake which regulates the quantity taken by the New River Company to 22,500,000 gallons a day, the quantity to which under arrangement with the East London Company, the company at present limit their supply.

The New River is about 26 miles long, and commences at the Chadwell Springs between Hertford and Ware, being shortly joined by an

artificial cut bringing the supply from the River Lea. It runs through Broxbourne, Cheshunt, Enfield, and Southgate to Hornsey, thence to Stoke Newington, where the principal works of the company are situate, and finishes at the New River Head, Clerkenwell. At intervals between Chadwell Spring and Hornsey are the following wells, with pumping machinery for raising water from the subterraneous reservoirs in the chalk into the river channel: — Broadmead well, above Ware; Amwell-end well, at Ware; Amwell-hill well, below Ware; Amwell-marsh well, between Ware and St. Margaret's; Rye Common well, at St. Margaret's; Hoddesdon well; Broxbourne well; Turnford well, between Broxbourne and Cheshunt; Cheshunt well; Hoe-lane well, above Enfield; White Webbs well, at Enfield; Highfield well, at Edmonton; Campsbourne well at Hornsey; Betstile well, at New Southgate.

The New River Company have also deep wells at Hampstead-heath, at Hampstead-road, and at Bush-hill-park, Edmonton, but these wells have no pumping machinery.

In addition to the above sources of supply, the New River Company will have the right to take 11⅝ million gallons daily from the Thames when the Staines Reservoir Works are completed.

The company have at Cheshunt two storage reservoirs, with a joint capacity of 39,000,000 gallons, which can be filled from the adjoining well.

At Hornsey, 7,000,000 gallons daily pass from the river through subsiding and storage reservoirs, with a total available capacity of 8,500,000 gallons, into eight filter beds having a total filtering area of 5¼ acres, whence the water is pumped to service reservoirs at Crouch-hill, Bourne-hill, Maiden-lane, and Hornsey-lane. From Hornsey the river flows to Stoke Newington, where the principal works of the company are situated. The water flows through two subsiding and storage reservoirs with a total available capacity of 90,000,000 gallons on to nine filter beds with a total area of nine acres, whence a daily average of about 19,000,000 gallons is pumped by one compound Worthington and six compound beam pumping engines to the service reservoirs at Crouch-hill and Maiden-lane for distribution into the town district of the company.

The remainder of the water travels on to the end of the channel at the New River Head, Clerkenwell, where it passes through a subsiding reservoir on to three filter beds, with a total area of 2¼ acres, from which about 6,000,000 gallons daily are raised to a service reservoir in Claremont-square.

The capacities and levels at the full water lines of the various reservoirs are as follows:—

	Capacity in Gallons.	Feet above O.D.
Claremont-square	3,500,000	139·00
Crouch-hill	12,000,000	195·50
Bourne-hill	1,500,000	195·50
Maiden-lane	15,000,000	232·00
Hornsey-lane	3,000,000	348·20
Southgate	1,000,000	308·00
Highgate	1,000,000	432·50
Hampstead	500,000	446·20
Total	35,500,000	

At three of the reservoirs there are stand-pipes, by pumping into which water can be supplied to further heights as under:—

	Feet above O.D.
Claremont-square	185·00
Highgate	481·80
Hampstead	486·30

There are also at Hampstead and Highgate, ponds having a total available capacity of 29,000,000 gallons, from which separate pipes supply street watering posts and other non-domestic services.

This company are also constructing works at Hanworth and laying a 36-inch main to convey to their district the 11⅝ million gallons of daily supply which will be available from Staines. These works are being designed and are under the direction of Mr. J. Francis, M.Inst.C.E,

The East London Water Works Co.

The East London Water Works Company was established in 1808 and authorised to purchase two existing waterworks, one situate at Shadwell, started in 1669, the other at West Ham, started in 1747. The company constructed settling reservoirs at Old Ford, with an area of about 11 acres, which were supplied from the River Lea within tidal influences. A service reservoir was also constructed at Mile-end with the necessary pumping machinery. In 1829 the company purchased the Hackney Waterworks and Lea-bridge Mills, and obtained an Act to enable them to remove their intake from Old Ford to Lea-bridge, whence the water was brought to the Old Ford reservoirs by an open conduit and thence pumped for use. In 1852 and 1853 the company's district was defined, and authority was obtained to make a new cut in connection with the

River Lea, for improving the quality of the water, to construct large impounding reservoirs at Walthamstow and filter beds at Lea-bridge, and to make an intercepting cut on the western side of the Lea from Tottenham to beyond Ponders End for the purpose of preventing polluted water from entering the river above the company's intake. In 1852 and 1862 Acts were passed for increasing the capital of the company. In 1867 an Act was passed enabling the company to construct a covered service reservoir in Finsbury-park, and to establish works at Sunbury and Hanworth with the necessary engines and main to convey 10,000,000 gallons a day from the Thames to the company's district. In the same year a separate Act gave powers to increase the number of reservoirs at Walthamstow and filter beds at Lea-bridge, to fill up the open reservoirs at Old Ford, and to cease using the open canal communicating with the open reservoirs and the works at Lea-bridge. In 1881 and 1886 Acts were passed for increasing the capital, and in the latter Act the company took power to sink wells and to construct further works to guard against pollution above their intake. The works at Old Ford were finally abandoned early in 1892.

The places and parishes in which the East London Company are by their Acts authorised to supply water are as follows :—*

Middlesex.—Whitechapel, Mile End Old Town, Mile End New Town, Spitalfields, Bishopsgate, Artillery Ground, Aldgate, St. George's East, Shadwell, Limehouse, Wapping, Ratcliff, St. Luke Old-street, Stoke Newington, Bow, Bromley, Stepney, Poplar, Bethnal-green, Shoreditch, Hackney, Tottenham, Old Ford, Homerton, Clapton, Kingsland, Shacklewell, Holloway, Stamford-hill, Dalston.

Essex.—West Ham, East Ham, Low Leyton, Leytonstone, Leyton, Walthamstow, Waltham Abbey, Waltham Cross, Ilford, Stratford, Romford, Dagenham, Wanstead, Woodford, Chigwell, Loughton, Chingford, Barking.

Sources of Supply.

The company takes its supply of water from four separate sources.

(1) From the River Lea, the intakes being at Enfield Lock and Ponders End.

(2) From deep wells in the chalk at Walthamstow, Chingford, Lea-bridge, and Waltham Abbey. Three additional wells are being sunk at Rammey Marsh, Ponders End, and Barking.

(3) From the River Thames at Sunbury.

(4) From springs at Hanworth.

The company's works are 10 in number, situate at Lea-bridge, Walthamstow, Chingford-hill, Woodford, Buckhurst-hill, Hornsey Wood, Sunbury, Hanworth, Waltham Abbey, High Beach.

Lea-bridge.—The water flows from the reservoirs at Walthamstow in an open channel $1\frac{1}{4}$ miles long to the filter beds, of which there are 25, with a total area of 24 acres. The filtered water is pumped into the district by 10 engines and 4 turbines, with an aggregate horse-power of 2,710. There is a deep well in the chalk whence water is pumped by an engine of 250 horse-power. The chief offices of the engineering department, stores, testing and workshops, are at this station.

Walthamstow.—At this station are 10 storage reservoirs, with a total capacity of 1,215,000,000 gallons. The reservoirs are fed from the Lea at Enfield Lock and Ponders End, the two conduits joining a short distance above Chingford Mill. Three reservoirs are high level and three low level. The former receive their supply from the head and the latter from the tail of Chingford Mill. Powers were taken by the Act of 1897 to construct additional reservoirs of 1,000,000,000 gallons capacity, and the company are promoting a Bill in the present Parliamentary Session for about 5,000,000,000 gallons of additional storage and other works at a total cost of £1,500,000. At this station a well has been sunk into the chalk whence water is pumped by a 250 horse-power engine, which a 350 horse-power engine pumps eastward to Hagger-lane and westward to Hornsey Wood reservoirs.

Chingford Mill.—Here are two wells, from one of which the water is pumped by turbines to Woodford under a pressure of 230 feet, while a quadruple expansion engine pumps the water from the other well.

Woodford.—These works comprise two covered service reservoirs of a joint capacity of 3,000,000 gallons, the head water level being 171 above O.D. and two engines each of 60 horse-power for pumping to the higher districts.

Buckhurst-hill.—A water tower of 70,000 gallons, with an altitude of 328 above O.D. was erected in 1879 and a service reservoir containing 7,000,000 gallons has recently been completed.

Hornsey Wood.—This reservoir is situated

*Appendix to Report of Royal Commission, 1892-3, page 9.

in Finsbury-park, has 5,000,000 gallons capacity, and is connected with the Thames supply and with the Lea-bridge works. Its height is 142 feet above O.D.

Sunbury.—The intake is in the county of Surrey in an eyot in the Thames above Sunbury Lock. Two engines, of 75 horse-power each, pump the unfiltered water to Hanworth, about two miles.

Hanworth.—The unfiltered water from Sunbury is delivered into an open reservoir containing about 5,000,000 gallons, whence it flows on to 6 filter beds having a joint area of 5 acres, and from the filters into 2 covered reservoirs, having a joint capacity of 2,500,000 gallons. Underground water is obtained from gravel beds in which collecting tunnels have been driven. Five engines, of 630 total horse-power, force the water over a tall stand-pipe, and through about 19 miles of 36-inch main to the Hornsey Wood reservoir in Finsbury-park, whence it gravitates over the company's western district.

Waltham Abbey.—A deep well has here been sunk into the chalk, whence the water is pumped by triple-expansion engines to the surface of the ground, and thence to the High Beach reservoir.

High Beach Reservoir. — The reservoir, which can be filled either from Waltham Abbey or from Woodford, is situate in Epping Forest, near to the King's Oak. Its capacity is 2,500,000 gallons, its altitude 371 feet above O.D., and it supplies the company's high-level district in Essex.

The East London now supply more water than any of the other London companies, their average daily supply, in 1897, being 41,036,906 gallons distributed to a population numbering 1,261,732.

Mr. W. B. Bryan, M.Inst.C.E., is the engineer to the company.

The West Middlesex Water Works.

The company was incorporated in 1806 by Act of Parliament, which empowered them to supply with water the parishes of St. Paul's, Hammersmith; All Saints', Fulham; St. Mary Abbott's, Kensington; St. Nicholas', Chiswick, with other parishes in the county of Middlesex, and also certain parishes in the county of Surrey, to which, however, the company did not give any supply. By a further Act of 1810 the limits of supply were enlarged, and by another Act of 1866 the district was extended to the parishes of St. John's, Hampstead; Hendon; Willesden, a small portion of Acton, all in Middlesex.

Descriptive Summary of the Works.

The intake of the company from the Thames is at Hampton, where there are a pair of engines, 900 horse-power, capable of delivering 32,000,000 gallons per day, and one engine of 400 horse-power, capable of delivering 24,000,000 gallons per day into the subsiding reservoirs at Barnes, a distance of nine miles, through two 36-inch cast-iron mains.

At Barnes there are seven subsiding reservoirs with a total available capacity of 397,000,000 gallons—four of which have recently been constructed upon the recommendation and to the designs of Mr. Hervey, M.Inst.C.E., the company's engineer—and eleven filter beds, having a filtering area of four acres, are in course of construction. The water is filtered through a stratum of washed sand 2 feet 9 inches thick, superposed upon a stratum of various sized stones, 1 foot in thickness.

At Hammersmith, the station on the Middlesex side of the Thames, the water is pumped for the supply of the whole district. The water gravitates from Barnes to the engine wells through a channel 8 feet in diameter, which has recently been constructed under the bed of the river.

The engine-power available is 1,605 horse-power, capable of pumping 30,000,000 gallons daily. Nearly the whole of the district is supplied by direct pumping, by means of three 30-inch mains, two 21-inch mains, one 14-inch main, and one 10-inch main. Three service reservoirs are also supplied from Hammersmith at Kensington, Barrow-hill, and Willesden. The higher parts of the country district are supplied by pumping a second time at Barrow-hill and Willesden.

At Barrow-hill the available engine-power is 180 horse-power, capable of pumping 6,000,000 gallons per day, by means of three trunk mains, two 15-inch, and one 16-inch in diameter. The service reservoirs supplied from Barrow-hill are at Kiddepore and Shoot-up-hill. At Willesden the available engine-power is 84 horse-power, capable of pumping 4,000,000 gallons daily, by means of a main 16 inches in diameter, running to the service reservoir at Shoot-up-hill.

The situation, capacity, and elevation of the service reservoirs are as follows:—

	Height above Ordinance Datum.	Capacity in Gallons.
Kensington, Campden-hill..	120	3,672,000
Barrow-hill, by Primrose-hill	190	4,750,000
Willesden, Harlesden	190	2,500,000
Shoot-up-hill, Mill-lane, by Edgware-road	257	6,000,000
Kiddepore, Platt's-lane, by Finchley-road	323	2,500,000
Total..........		19,422,000

The above filtered-water reservoirs are all covered. All engines and trunk pumping mains are in duplicate. The total quantity of water that may be drawn from the River Thames, by agreement with the Thames Conservancy, is 24,500,000 gallons per day, to which will be added a further supply of $11\frac{3}{8}$ million gallons daily when the Staines Reservoir Works are completed.

The average daily supply in 1897 was 20,337,019 gallons, distributed to a population of 601,509.

The Grand Junction Water Works Company.

The company was incorporated by Act of Parliament in 1811, which transferred to the company Parliamentary powers for supplying certain western districts of the metropolis, under the Act granted to the Grand Junction Canal Company in 1798. The original works were situated at Paddington, and the supply was taken from the canal till 1826, when the source of supply was removed to the River Thames at Chelsea. In 1835, the intake was removed to the works at Kew-bridge. In 1852, the company's source of supply was removed to its present position at Hampton.

Area of Supply.—The company's area of supply includes the parishes of Paddington, Kensington, Marylebone, St. George's, Hanover-square, St. James, Westminster, Hammersmith, Brentford, Ealing, Chiswick, Acton, Hanwell, Isleworth, Twickenham, Teddington, Hampton, Hampton Wick, Hampton Court, Bushey-park, Whitton, Hanworth, and Heston, all in the county of Middlesex.

Description of Works.

The works are situated in the Hampton and Sunbury parishes, Middlesex, upon the north side of the Thames, at Kew-bridge, at Campden-hill, and at Ealing. The intakes from the River Thames are at Hampton.

The old intake, constructed in 1853, is situated opposite Platt's Eyot, about a quarter of a mile above Hampton Church, and consists of two 36-inch pipes with sluices. This intake delivers water direct into the low-level filters for the supply of the country districts, and to the "bull engines," which formerly pumped the water to Kew, but are now held in reserve for use upon emergency.

The new intake is situated about one mile higher up the river, upon an islet opposite Kenton Court, where a chamber, commanded by sluices, and protected by a grating, has been built, and is connected by 30-inch pipes to a chamber on the north bank of the river. The top of these chambers is raised to a level above the level of the highest recorded flood. From the second chamber the water is conveyed by two 36-inch pipes, laid under the Lower Sunbury-road, to the wells of the low lift pumping-engines, about half a mile distant.

Gravel Beds.—In a 10-acre field immediately opposite the new intake, but upon the north side of the lower Sunbury-road, the gravel beds form a natural filter, from which the water is drawn through 24-inch drain pipes with open joints connected with the third line of pipes 30 inches in diameter laid along the lower Sunbury-road to the works, and these can also be connected direct to the river. A channel has been formed in the centre of the field, through which the land can be charged with water from the river when desirable. The bottom of the channel is constructed as a filter, the sand of which can be removed and washed when necessary. These gravel beds are treated by the company, and recognised by the Water Examiner as practically an addition to their storage resources.

The works at Hampton consist of a storage and subsidence reservoir, having a capacity of 45,000,000 gallons. A large proportion of the supply from the river is pumped into this reservoir, whence it is drawn off through two water towers provided with sluices, so that the water may be drawn off from the surface whatever may be its level. The total area of filters at Hampton is $15\frac{3}{4}$ acres. The filters are generally constructed as shown by the type diagram upon the wall. The filtering material consists of washed sand, 3 feet in thickness, resting upon gravel and stones 2 feet thick, gradually increasing in size towards the bottom of the filter. As the stones in the gravel found upon the works were not sufficiently large, the concrete bottom of the filter has 2-inch drain pipes, 1 yard apart, laid over it, which run to the collecting main in the centre. The water is delivered into the filters by a bell-mouthed

pipe, just above the top sand level. It flows over the surface of the sand to the depth of about 5 feet, and passes through the sand and the gravel into the collecting drain, running along the centre of the filter bed, whence it is delivered through cast-iron pipes to the engine wells. Valves are provided for regulating the supply and delivery of the water, so that the water shall pass through the filtering medium at a rate not exceeding a maximum of 2½ gallons per square foot of filtered surface per hour.

The country district is supplied from the Hampton Works by a pair of compound beam engines and a "Davy" engine, to which a vertical triple expansion engine is now being added. The water is pumped through one 30-inch and one 12-inch main running through New Hampton into the Twickenham-road, along which the 30-inch main proceeds past the Kew Works to which it has two connections. It then supplies part of Shepherd's-bush, and is finally connected into the Campden-hill reservoir. The 12-inch main after diverging through Twickenham, follows the same course to Turnham-green, whence it passes through Goldhawk-road and Uxbridge-road, and finishes in Ladbroke-grove by a connection to the Kew 30-inch main.

Kew-bridge Works. – The water is pumped from Hampton to Kew through two 33-inch mains, one running along the Twickenham-road, through Isleworth to Kew-bridge, the other through New Hampton past Hospital-bridge, and through Whitton and Isleworth to Kew-bridge, which it enters at the back of the works. This latter main will also be used for the supply of the western part of the district as the population increases.

At the Kew-bridge Works there are: – One upper reservoir, 8,500,000 capacity; one lower reservoir, 5,000,000 capacity; eight filter beds, 8¾ acres area; one filter water reservoir (covered), 2,500,000 capacity.

From the Kew-bridge Works, the town district is supplied by two 30-inch mains, one running almost due east through Turnham-green and Bedford-park, along Uxbridge-road (with a branch to Campden-hill and Oxford-street) terminaring near Poland-street. The other 30-inch main turns up Gunnersbury-lane (whence there is a 30-inch main to Ealing Reservoir), Acton, Ladbroke-grove, Notting-hill-gate, Grand Junction-road, and finishes in the Edgware-road, where it is connected with a 24-inch main, supplied from Campden-hill.

Engines.—There are 8 pumping engines at these works, having a pumping capacity of about 26,000,000 gallons in 24 hours.

Ealing Works.—At Ealing, upon the top of Hanger-hill, the company possess a service reservoir for filtered water, having a top water level of 205 feet above O.D., and having a capacity of 3,000,000 gallons, and a large storage reservoir containing 50,000,000 gallons, having its top water level 193·5 feet above O.D. For the supply of the higher part of the neighbourhood a water tower with cast-iron tank on the top, having a top water level of 265 feet above O.D., has been erected.

Campden-hill Works.—At these works there are 3 filtered water storage reservoirs, having a total capacity of 18,000,000 gallons, and 3 pumping engines capable of raising about 20,000,060 gallons daily into a standpipe to a level of 270 feet above O.D. The supply of the high level district of the company is given from these works.

Powers of Supply.—The company has statutory powers to take from the Thames any water that is required for the purpose of their district. Under the agreements of 1852 and 1886 with the Thames Conservancy these powers are at present exercised to an extent not exceeding 24,500,000 gallons daily. When the Staines Reservoirs Works are completed the company will have an additional supply of 11⅔ million gallons daily. The average quantity of water supplied daily in 1897 was 19,532,580 gallons to a population of 398,390.

Chelsea Water Works Company.

The company's intake is situated at West Molesey in the county of Surrey, on the south bank of the Thames, the Thames being the only source of supply. The works consist of of the intake, pumping power equal to 35,000,000 gallons, and four reservoirs whence it is delivered to the Surbiton Works by gravitation. These reservoirs have a total capacity of 140,000,000 gallons, but are now being enlarged to contain 189,000,000 gallons, under the direction and to the design of Mr. R. Hack, M.Inst.C.E. The water is delivered from Molesey to Surbiton through two 36-inch mains. The works at Surbiton contain eight acres of filtering area and pumping power equal to 22,000,000 gallons in 24 hours, which allows of a large margin of reserve for any contingency. From Surbiton the filtered water is pumped to Putney-heath through three mains, one of 30-inch diameter for the whole distance, one 30-inch reduced to 24-inch on the top of Kingston-hill, and one

15-inch main. The storage capacity of the filtered water reservoir at Putney-heath is 11,000,000 gallons, which capacity is being doubled by works now under construction. The top water level reservoirs are 175 feet above O.D., which can be increased to 197 feet above O.D. by pumping over a standpipe.

Distributing Mains.—From the service reservoirs on Putney-heath there are five trunk lines of distributing mains. These mains, of which three are of 30-inch diameter, and two of 15-inch, cross Putney-heath and enter the main road at the top of Putney-hill. At this point they are reduced in diameter to 24-inch and 12-inch respectively, and passing down Putney-hill cross the South-Western Railway by an aqueduct bridge, and the Thames beneath the footways of Putney-bridge. From the north end of Putney-bridge three 24-inch, one 18-inch, and two 12-inch mains distribute the water over the whole of the district of the company.

District of Supply.—The Chelsea Company's district of supply is situated wholly within the metropolis, consisting of an area of five square miles, extending from Charing-cross to the "Crabtree," Fulham, and bounded by the River Thames on the south, and on the north-east and north-west by the Grand Junction, New River, and West Middlesex Companies. The population supplied was 276,691 in 1897, and the average daily quantity of water supplied was 12,079,000 gallons.

The company have power to abstract 22,000,000 gallons of water daily from the Thames, which gives a large surplus beyond that required for the present supply of the district. It is estimated that the eventual maximum daily supply when the company's district is entirely built over will not exceed 17,500,000 gallons.

Lambeth Water Works Company.

The area of supply of this company consists of the parishes of Thames Ditton, Esher, Long Ditton, Kingston, Putney, Malden, Marden, Wimbledon, Merton, Morden, Tooting Graveney, Clapham, Wandsworth, Battersea, Streatham, Croydon, Newington Butts, Newington, Bermondsey, Camberwell, Lambeth, Horselydown, St. Saviour's, St. George-the-Martyr, Christchurch, St. Olave, St. Thomas, the Clink Liberty in Southwark, and such parts of Beckenham and Lewisham as lie on the western side of the River Ravensbourne.

Works.—The principal intake of the company from the Thames is at West Molesey, where there are a pair of pumping engines of 100 horse-power and a pair of engines working two centrifugal pumps, the total engine-power being capable of pumping 42,500,000 gallons per day into the subsiding reservoirs or into the conduit hereafter mentioned, as occasion may require. The present storage capacity of the reservoirs is 125,000,000 gallons, which is now being increased to 465,500,000 gallons, by the advice and to the designs of Mr. T. F. Parkes, M.Inst.C.E. The company have powers to take 24,500,000 gallons daily from the Thames, while an additional quantity of spring water can be obtained from under the land at the Molesey Works to the extent of from 6,000,000 to 8,000,000 gallons daily. From the reservoirs the water flows by gravitation, a distance of 3½ miles to the filtration works and main pumping station at Ditton, through two means of communication: (1) a brick conduit of oval shape 5 ft. 9 in. high and 4 ft. 9 in. wide, with intervals of cast-iron pipes 54 in. in diameter, and (2) an iron pipe 36 in. in diameter. There is also an intake at Ditton, but this is only used when from special causes the intake at Molesey is not available.

Ditton Works.—At Ditton, about one-third of the unfiltered water is delivered on to four low level filter beds, and the remainder into a suction reservoir at the same level. Three engines of a total capacity of 280 horse-power, lift the water from the suction reservoir into a reservoir serving 8 filter beds 16 feet higher than those referred to. The two reservoirs contain together 3,000,000 gallons. There are in all 12 filter beds containing a filtering area in the aggregate of 12½ acres. The filtering material is composed of 3 feet of washed sand and 3½ feet of fine and coarse gravel.

From Ditton the bulk of the water is pumped through three mains, each 30 in. in diameter, a distance of 10 miles into two reservoirs at Brixton, the remainder being pumped into a reservoir at Coombe through two mains each 12 in. in diameter which also serve as distributing mains. The reservoir at Coombe supplies by gravitation the districts of Esher and East and West Molesey through two mains, each 10 in. in diameter. Kingston is also supplied by these pumping mains. The total engine-power available at Ditton is 150 horse-power for the Coombe reservoir, and 1,660 horse-power for the reservoirs at Brixton, and 330 horse-power for Coombe and Brixton alternatively. These engines are capable of

pumping, approximately, 3,000,000, 7,000,000, and 39,000,000 gallons per day respectively.

From the Brixton Works water is supplied by gravitation into the town district, the whole of which is on constant service through four trunk mains, respectively 24, 20, 18, and 12 inches in diameter, while the water for the country district is pumped from the station by 10 engines of 1,005 horse-power into service reservoirs, through 9 trunk mains, which also serve as distributing mains. The water is distributed from these reservoirs through 15 leading mains, varying from 10 to 18 inches in diameter.

The service reservoirs for the supply of the country district are as follows :—

	Height above O.D.		Capacity in gallons.
Coombe (1 reservoir)....	180	..	1,150,000
,, (standpipe)	220	..	—
Brixton (2 reservoirs)....	115	..	12,000
Streatham (2 reservoirs)..	198	..	7,500,000
Selhurst (1 reservoir)....	218	..	2,500,000
,, (standpipe)	230	..	—
Norwood (1 reservoir) ..	315	..	5,000,000
Rock Hill (1 reservoir) ..	372	..	} 6,150,000
,, (tank)	387	..	
,, (standpipe) ..	412	..	—
			28,765,000

The average quantity of water supplied in 1897 was 23,688,305 gallons daily to a population of 666,981.

Southwark and Vauxhall Water Works Company.

The Vauxhall Company was founded in 1805, and the Southwark Company in 1822, the two companies being amalgamated under the name of the Southwark and Vauxhall Company, in 1846. The supply was originally obtained from the River Thames at Battersea, but under the Act of 1852, the intake was removed to Hampton. Under their statutory powers there is no limit to the quantity of water which the company may take from the Thames, but the amount is restricted by agreement with the Thames Conservancy to a quantity of 24,500,000 gallons through their intake at Hampton. In 1897, however, the company obtained temporary powers to take an additional quantity of 20,500,000 gallons daily from the Thames, which were made permanent by an Act passed in 1898; conditionally upon their constructing the storage reservoirs proposed under that Act, and with the restriction that the water may only be taken from the surplus above 285,000,000 gallons flowing at Penton Hook Weir. When these works are completed the company will therefore have powers to take 45,000,000 gallons daily permanently from the Thames.

In addition to the above sources of supply the company obtained Parliamentary sanction in 1884 to purchase lands, sink wells, and construct the necessary works to supply water therefrom. The first well was sunk at Streatham, and from this a quantity between 2,000,000 and 2,500,000 gallons daily has been regularly obtained. since July 1st, 1895. At Merton the work of sinking another well is in progress, while further wells are under contemplation.

Districts of the Company.—The districts supplied by the company comprise part of Southwark, portions of Lambeth and Peckham, and the whole of Battersea, and also includes Ham, Petersham, Kew, East Sheen, Sheen, Roehampton, Mortlake, Barnes, Putney, and such parts of the parish of Wimbledon as are above the 100 feet Ordnance contour. The company also supply Richmond to a considerable extent with water in bulk, under the agreement incorporated with the Companies Act of 1897.

Works.—The present works of the company are at Hampton, Battersea, Nunhead, Wandsworth, Forest-hill, Streatham, Raynes-park (site of proposed works) Honor Oak.

Reservoirs and Wells.—At Hampton there are three storage reservoirs with a total capacity of 390,000,000 gallons. The company also possess natural filtration works in the gravel at this station with an area of 39¾ acres. The number of filters in use is nine, having an area of 9¼ acres; an additional area of about 7 acres will probably be completed during the present year. The filtering material consists of 3 feet of sand, 1 foot of hoggin, 9 inches of fine gravel, and 9 inches of coarse gravel.

Engines with 26,000,000 gallons daily capacity pump the water to Nunhead or into the district, engines in duplicate of 16,000,000 gallons capacity lift the water obtained from the natural filtration works, two pairs of single-acting quadruple expansion high-speed engines, driving centrifugal pumps with 20,000,000 gallons daily capacity, raise water rom the river to fill the reservoirs, and three inverted direct-acting Cornish engines of the "Bull" type with 23,000,000 gallons daily capacity pump the unfiltered water to the Battersea works.

Three sets of triple expansion rotative pumping engines with direct-acting pumps are now in course of erection.

Battersea Works.—The unfiltered water

delivered by the 36-inch main from the intake of the works at Hampton is received at Battersea into three reservoirs having a total capacity of 46,000,000 gallons, which then pass through the filters, of which there are $11\frac{1}{4}$ acres, and is distributed by six Cornish engines, having a total capacity of 31,500,000 gallons daily.

Nunhead.—The works at Nunhead consist of four reservoirs, two with a top water level of 168 feet above O.D., each having a capacity of 6,000,000 gallons, and two with a top water level of 200 feet above O.D., each having a capacity of 3,000,000 gallons. Those reservoirs supply by gravitation a portion of the eastern part of the district, and also a portion of the Peckham and Dulwich districts. The engines are single acting, of the Cornish type, of 7,000,000 gallons capacity per day. A preliminary boring has been sunk at these works which struck the chalk at a depth of 167 feet.

Wandsworth.—The works at Wandsworth contain two pairs of direct acting quadruple expansion rotative engines capable of pumping 9,000,000 gallons daily to the high level districts and reservoirs at Forest Hill. These engines draw their supply from the 30-inch main from Hampton.

Forest Hill.—At Forest Hill there are two reservoirs, each having a capacity of 500,000 gallons with a top water level of 140 feet above O.D.

Streatham.—The works at Streatham consist of two pairs of 3 cylinder triple expansion engines with lift and pressure pumps delivering about 2,500,000 gallons daily against a head of 200 feet.

The average daily supply of the company in 1898 was 32,743,058 gallons; the estimated average population was 816,894.

Mr. J. W. Restler, M.Inst.C.E., is the engineer to the company.

Kent Water Works Company.

The company, incorporated by Special Act in 1809 and extended under subsequent Acts of 1811, 1852, 1864, 1877, and 1888, now supply water within an area of 178 square miles, comprising many rural districts in Kent.

The population supplied was estimated to be at the end of 1897, 519,340, the number of supplies being 86,390. The average day's quantity supplied in 1897 was 15,482,053 gallons, or at the rate of $29\frac{3}{4}$ gallons per head of the population. About $93\frac{1}{2}$ per cent. of the supplies are on the constant service.

Sources of Supply.—The supply of water throughout the company's area is obtained entirely, with one exception, from the chalk strata between the north downs and the Thames by means of deep wells and borings, situated as follows:—

		Wells.
Deptford	(chalk)	3
Plumstead	,,	1
Crayford	,,	3
Shortlands	,,	2
Farnborough	,,	2
Wilmington	,,	2
Westerham	(green sand)	1
		14

A second well has been sunk in the chalk at the Wilmington pumping station, largely augmenting the yield of water there. The company are now sinking, and have nearly completed, another well in the chalk, in the parish of Southfleet, near Gravesend, and a second well, also in the chalk, at Kent Gate, in the parish of West Wickham. The pumping stations are 8 in number, situated on the sites of the wells. At Deptford there are 6 pumping engines, with a total capacity of 25,170,000 gallons in 24 hours, supplying reservoirs at Deptford, New Cross, Greenwich-park, and Woolwich-common. At Plumstead, a rotative pumping-engine will pump 1,296,000 gallons in 24 hours, supplying reservoirs at Plumstead-common.

At Shortlands are two Cornish engines, with a total capacity of 2,750,000 gallons daily, supplying Chislehurst. At Crayford 3 pumping engines, with a total capacity of 4,500,000 gallons, supply Woolwich Common and Eltham. At Dover-road a pair of horizontal rotative engines can pump 364,000 gallons in 24 hours for the extra lift to Shooter's Hill. At Farnborough are 4 pumping engines, with a total capacity of about 5,128,000 gallons in 24 hours, supplying Farnborough, Knockholt, Constitution Hill, and West Wickham. At Wilmington a pair of compound rotative pumping engines, with lift and force pumps, can deliver 8,000,000 gallons daily to Eltham. At Westerham there is a water wheel with pump which supplies 250,000 gallons daily to Westerham. Mr. W. Morris, M.Inst.C.E., is the engineer to the company.

Staines Reservoirs Works.

The evidence given before Lord Balfour's Commission in 1892 showed that whereas an average daily flow of 1,350,000,000 gallons was passing down the river, only 90,000,000 gallons were being taken for water supply. It therefore

appeared evident to me that if some of the superabundant water was stored when the river was running with a high flow, it could be used for water supply when the river was running at its minimum flow, which the Thames Conservancy consider should be 200,000,000 gallons daily at Teddington Weir. Having explained the principle of the scheme to my colleagues on the Grand Junction Waterworks Board, they instructed their engineer, the late Mr. A. Fraser, M.Inst.C.E., to co-operate with me in the matter. We went carefully into the question, and presented a report to the Royal Commission, who approved the scheme. Difficulties arose in regard to its execution, but eventually in 1895 the New River Company, West Middlesex Company, and Grand Junction Company, instructed Mr. R. E. Middleton, M.Inst.C.E. and myself to prepare a scheme for Parliament. Certain modifications in the design of the works were suggested by Mr. Middleton, in the desirability of which I concurred. The Staines Reservoirs Act was passed in the Session of 1896. By it a Joint Committee, consisting of nine members, three from each company, were constituted, with powers to carry out the works, which are now being constructed to the designs and under the superintendence of Mr. Middleton and myself. The contract is let to Messrs. John Aird and Sons.

The works consist of two large reservoirs, having a total capacity of 3,300,000,000 gallons situated about half a mile to the north-east of the town of Staines. The intake from the Thames is situated on the Middlesex bank of the river, about 300 yards above Bell Weir; at this point sluices and a sluice house are being constructed, the intake being protected by screens. The first length of the conduit for about 350 yards is covered, but after passing the Colne Brook it continues as an open conduit to the engine-house, up to which point it has a capacity of 147,000,000 gallons daily, with a fall of about 9 inches per mile. The pumping machinery will consist of five triple expansion surface-condensing Worthington pumping engines, one being a spare engine, each capable of delivering 16,000,000 gallons daily into the reservoirs. The steam will be provided by six Babcock and Willcox boilers, one a spare boiler, the working pressure being 150 lbs. per square inch. The water will be delivered into the reservoirs through two riveted steel mains, each 6 ft. 3 in. in diameter, joining into a steel pipe 8 ft. 8 in. internal diameter, near the reservoirs, from which branch pipes of the same diameter will be taken down through a tunnel constructed in the clay, and connected to the water tower near the corner of each reservoir, where the western and central embankment joins. The tunnels and water towers will be constructed of Portland cement concrete; the former lined and the latter faced with blue bricks. The stand pipes for discharging water from the reservoirs will be of cast-iron, 5 ft. internal diameter, having 48-inch and 36-inch sluice valves to enable the water to be drawn off at any desired level. From the bottom of each stand pipe a cast iron pipe, 4 ft. in diameter, will convey the water through the tunnel and across the New Stanwell road to a basin 50 ft. in diameter, in which a weir will be constructed for the purpose of aeration, and over which the water will be delivered into the conduit, which will rejoin the main conduit a little to the east of the pumping station. The reservoirs are being constructed with earthen banks, excavated from the interior area of the reservoirs. In the centre of these banks a puddle wall is being constructed down into the solid clay, thus forming a perfectly tight reservoir. The clay for the puddle wall is being excavated within the area of the reservoirs below the top stratum of gravel, which varies from 14 ft. to 35 ft. in thickness.

From the engine-house the conduit reduced in section follows the line shown upon the map, passes at the back of the East London Waterworks at Hanworth, at which point it will deliver water to the new works of the New River Company, and finishes in a reservoir of 30,000,000 gallons capacity at Hampton, whence the water will be delivered into the works of the West Middlesex and Grand Junction Companies.

Under the Staines Reservoirs Act the Joint Committee have power to supply 35,000,000 gallons daily to the Joint Companies, or 45,000,000 gallons daily under emergency by consent of the Local Government Board. The maximum quantity allowed to be taken from the river for supply and for filling the reservoirs is restricted to 100,000,000 gallons in 24 hours, but this quantity must be taken out of the surplus water above a flow of 265,000,000 gallons daily at Bell Weir.

Southwark and Vauxhall Company's Storage Scheme.

Under this Company's Act of 1898, the company are about to construct at Molesey, under the advice of their engineer, Mr.

Restler, storage reservoirs of 1,070,000,000 gallons capacity, which, when completed, will give them the right to take the additional quantity of 20,500,000 gallons from the river before referred to.

Total Supply Authorised from the Thames.

From the foregoing descriptions, it will be seen that the total quantities of water which the companies have power to take daily from the Thames upon the completion of the storage works now being constructed are as follows :—

	Million gallons daily.
Chelsea Company	22
East London Company	10
Grand Junction Company	24·5
Lambeth Company	24.5
Southwark & Vauxhall Company .. 24·5 / Ditto under storage scheme .... 20·5	45
West Middlesex Company	24·5
Staines Reservoirs Joint Committee	35
Total	185½

Storage for the River Lea.

The East London Water Works Company have, under the advice of their engineer, Mr. Bryan, constructed large additional reservoirs and have deposited a Bill seeking powers for still larger works, which, it is hoped, will be passed in the present Parliamentary session.

Total number of supplies, December, 1898,	871,949
Miles of water-pipes	5,254¼
Total horse-power	26,723
Area of filtration (acres)	129½

5.—The Quality of the Water.

From the foregoing description of the companies' works, it will be gathered that the purification of the water supply to London is effected by sedimentation and by sand filtration. The question, whether the present supply was adequate in quality was definitely referred to Lord Balfour's Commission, which gave a verdict upon this issue in the following terms (see paragraph 178 of the Report of Royal Commission, Metropolitan Water Supply, 1892, 1893) :—

"We are strongly of opinion that the water, as supplied to the consumers in London, is of a very high standard of excellence and purity, and that it is suitable in quality for all household purposses. We are well aware that a certain prejudice exists against the use of drinking water derived from the Thames and the Lea, because these rivers are liable to pollution, however perfect the subsequent purification, even by natural and artificial means may be; but having regard to the experience of London during the last thirty years and to the evidence given to us on the subject we do not believe that any danger exists of the spread of disease by the use of this water, provided that there is adequate storage and that the water is efficiently filtered before delivery to the consumers."

The water supplied by the companies is daily analysed and bacterially examined on behalf of the companies by two eminent chemists, Sir W. Crookes, F.R.S., and Professor Dewar, F.R.S. Analyses are also made on behalf of the Local Government Board by Sir E. Frankland, F.R.S., who, at the request of the Associated Metropolitan Waterworks Companies, extends his examination to the chemical and bacterioscopic condition of the raw river waters at the intakes of the various companies and to the bacteriology of the water as it issues from the filter beds.

In regard to the results of the chemical analysis and of the physical and bacterioscopic examination of the water supplied during the year 1897, Sir E. Frankland reported as follows, under the date of January 31, 1898 :—

"In the following Table are recorded the results of observations respecting the freedom from turbidity or otherwise of the various waters, and, for the purpose of comparison, the results of my first observations in 1868 are also included :—

Companies.	Number of occasions when—							
	Clear and transparent.		Slightly turbid.		Turbid.		Very turbid.	
	1868	1897	1868	1897	1868	1897	1868	1897
Thames.								
Chelsea	7	12	2	0	1	0	2	0
West Middlesex	12	12	0	0	0	0	0	0
Southwark	1	12	5	0	4	0	2	0
Grand Junction	9	12	2	0	1	0	0	0
Lambeth	6	12	1	0	2	0	3	0
Lea.								
New River	10	12	2	0	0	0	0	0
East London	3	12	8	8	1	0	0	0
Deep Wells.								
Kent	8	12	3	0	1	0	0	0
Colne Valley	—	11	—	1	—	0	—	0
East London	—	4	—	8	—	0	—	0

"This Table strikingly exhibits the great improvement which the water companies who draw their supplies from rivers have effected in filtration since I first began these examinations for turbidity in 1868. In that year seven samples were so turbid as to be highly repulsive in appearance, nine were turbid, and no less than twenty slightly turbid; whereas during *the year* 1897 *no sample of filtered water was turbid in the slightest degree.* On the other hand, nine

samples of deep-well water, which does not usually require filtration, were slightly turbid, owing, in all probability, to disturbance by the pumping machinery.

"The purest water in nature contains abundance of suspended matter; indeed, the beautiful blue colour of the purest Swiss lakes and of the Mediterranean is due to these very fine suspended matters, which require years to subside, and which no sand filter will remove, but which may be extracted in the chemist's laboratory to some extent, though not completely by filtration through specially prepared paper This fine suspended matter, which is, of course, always present in the most efficiently filtered London waters, is under all ordinary circumstances absolutely invisible to the eye. The water is clear, bright, and transparent, but if a decanter of it be placed in a dark room, and a ray of sunlight or electric light allowed to fall upon it, the water will be seen to be full of suspended particles, which no sand or other practical filter is capable of removing, but which are partially arrested by a hard paper filter supported by a glass funnel. The amount of this suspended matter in the efficiently filtered river water supplied to the metropolis rarely, if ever, exceeds 0·0002 grain in a tumblerfull; and, therefore, in order to imbibe a single grain, it would be necessary for the consumer to drink no less than 5,000 tumblers full of the water. Such excessively minute quantities of matter, which is presumably harmless, may safely be neglected; indeed, it is impossible, practically, to obtain water free from it."

In regard to the bacterioscopic examination, Sir E. Frankland wrote in the same Report:—

"The standard of 100 microbes per cubic centimetre, as an indication of efficient bacterial filtration, adopted by Doctor Koch and myself, is, of course, purely arbitrary. I consider it is a sufficient, but not unduly, severe test to apply to the filtration of the river-derived supplies of the London water companies; but I desire it to be distinctly understood that the infraction of this standard does not throw suspicion upon the wholesomeness of the water."

Sir E. Frankland further wrote in the second Report:—

"These results of the bacterioscopic examination of the unfiltered waters used by the metropolitan companies are very instructive; they again show the remarkable effect of storage in reducing the number of bacteria. Thus, in March last, whilst the Thames at the intakes of the companies drawing their supplies from that river contained 50,560 microbes per cubic centimetre, the Chelsea Company, with ten days' storage, were supplying their filters with water containing only 580 microbes in the same volume. Again, in February, the East London Company, with twenty days' storage, kept the number down to 1,050 per cubic centimetre, although 44,600 per cubic centimetre were passing the intake at Angel-road."

In the same Report Sir E. Frankland gave the following particulars of the bacterial condition of the water issuing from the filtering beds of the various metropolitan companies, during the year 1897, compared with the raw material dealt with by these companies:—

Company.	Aver. percentage of microbes removed.
Chelsea	98·96
East London	99·24
Grand Junction	98·46
Lambeth	99·50
New River	99·09
Southwark and Vauxhall	97·72
West Middlesex	99·40

The Reports of Sir W. Crookes and Professor Dewar, as to the quality of the water, are equally satisfactory, and it is interesting to note the following extracts from their Report of October 14th, 1897:—

"In order to prevent any misapprehension in the public mind with regard to our monthly report on the quality of the London water, it may be advisable to repeat that the Water Companies in no way interfere with our position as absolutely independent scientific authorities. Further, they have no information antecedent to publication, as to what will appear in our report. Our communications with the companies are chiefly confined to calling their immediate attention to the least anomaly appearing in the character or the quality of the filtered water; our chief aim being to advise the engineers of the works as to the efficiency of storage and filtration.

"*There is no city in the world where such minute and incessant care is taken daily and almost hourly to detect and report on the slightest deviation from the purity in its water supply.* Apart from the daily bacteriological examination of the clear water wells of the company, we frequently make specific tests for the presence of pathogenic organisms. If any other than a negative result had been obtained the fact would have been recorded."

It will, I think, be conceded that the above Reports are eminently satisfactory.

But the strongest practical proof, in my opinion, of the excellence of the London water supply is to be found in the record of the Vital Statistics of the Metropolis. It will, I think, be conceded that no large city would have a death-rate of 18·2 (the death-rate of London for 1897) unless it possessed a water supply of excellent quality.

Before proceeding to the last head of this paper, it is desirable to mention that a comparison between the cost of the water supply in London (a comparison worked out for a number of towns by Doctor Powle, Mr. Asquith, and Mr. Alexander) as compared with the

charge made in Liverpool, Manchester, Sawford, Birkenhead, Brighton, Bolton, Bristol, Derby, Oldham, Stockton, and Newcastle, shows results which are very clearly stated by Mr. Arthur Shadwell in his recently-issued book upon the London Water Supply, in which he writes as follows :—

"The highest charge in London on the 10 per cent. valuation, that of the Lambeth Company, is appreciably lower than the provincial average, and the London average is no less than 40 per cent. lower. On the £20 valuation it is 32 per cent. lower, on the £30 valuation it is 26 per cent. lower, and on the £50 valuation 11 per cent. lower; only, when we come to premises rated at £100 and upwards, are the London charges higher than the provincial average. In other words, by the system of graduated water rates imposed by the London companies the rich pay for the poor. This is notably the case with the two companies who supply the great area of poverty, namely, the East London and the Southwark and Vauxhall. In fact these two companies, and especially the East London, supply their poorest customers at a loss, which is made good by the higher charges on the more heavily rated houses. Under municipal authority the rates would necessarily be equalised, and the poor would have to forego the advantage they now enjoy. This fact, which is studiously kept out of sight by progressive politicians, is worthy the attention of the poorer classes, in whose interests municipalisation is ostensibly advocated."

6.—The Supply in the Future.

Soon after the first London County Council was constituted, in 1889, it appointed a committee to consider the question of London water supply. After some inquiries and other proceedings, the Council requested the Government to issue a Royal Commission to inquire into the London water supply. Eventually, a Commission was appointed in March, 1892, consisting of Lord Balfour of Burleigh, Chairman; Sir George B. Bruce, Civil Engineer; Sir A. Geikie, Director-General of the Geological Survey; Professor Dewar; Mr. T. H. Hill and Mr. J. Mansergh, both engineers of large experience in connection with water supply; and Dr. W. Ogle. The Commissioners subsequently appointed Mr. R. E. Middleton, M.Inst.C.E., as an Assistant Commissioner for the purpose of making investigation into doubtful questions raised in the course of inquiry. The terms of reference were as follows :—

"Whether, taking into consideration the growth of the population of the metropolis and the districts within the limits of the metropolitan water works companies, and also the needs of the localities not supplied by any metropolitan companies, but within the watersheds of the Thames and the Lea, the present sources of supply of these companies are adequate in quantity and quality, and, if inadequate, whether such supply, as may be required, can be obtained within the watersheds referred to, having due regard to the claims of the districts outside the metropolis, but within those watersheds, or will have to be obtained outside the watersheds of the Thames and the Lea."

Any one reading this reference must see that four distinct issues were raised :—

1. Whether the present sources of supply are adequate in quantity.
2. Whether they are adequate in quality.
3. Whether such supply as may be required can be obtained within the watersheds referred to; or
4. Whether it will have to be obtained outside the watersheds of the Thames and the Lea.

The Commission sat forty-five days and took evidence from ninety-two witnesses, including the engineers and other officials of the County Council and the water companies. The conservators of the Rivers Thames and Lea, gave records of the flow of these rivers. The rainfall was treated by Mr. C. J. Symonds, F.R.S. and other meteorologists. Independent engineering and geological evidence was given by Sir F. Bramwell, Mr. T. Hawksley, Mr. Deacon, Professor Boyd-Dawkins and Mr. W. Whittaker.

Upon the question of quality, evidence was given by Sir E. Frankland, Sir W. Crookes, Dr. Odling, Dr. R. Lankester, Dr. Klein, Dr. Sims Woodhead, and others.

The Commission took into their purview the period of forty years, and basing their estimate upon the decennial increase between 1881 and 1891, arrived at an aggregate of the population in 1931 of 11¼ millions in the area, the water requirements of which were to be considered—viz., 845 square miles.

Taking the needs of this population at 35 gallons per head per day, the average daily quantity required in 1931 was found by the Commission (paragraph 70) to be 391,717,690 gallons. Adding 6 per cent. to provide for increased demand in hot weather and in times of frost, the Commissioners estimated the maximum daily provision required in 1931 at 415,219,752 gallons.

To meet this demand the Commission arrived at the conclusion that if adequate storage were provided for the Thames and the Lea, the following quantity of water would be available:—

	Million gallons per day.
From the River Thames	300
,, ,, Lea	$30\frac{1}{2}$
,, wells in the Lee valley	40
,, the Kent Company's district	$27\frac{1}{2}$
	420

Sufficient, at 35 gallons per head per day, for a population of 12,000,000.

The above figures, adduced by the Commission, show, in reply to the first and third heads of reference, that the present sources of supply are adequate in quantity, and that such supply as may be required can be obtained within the watershed for the Thames and Lea. I have already dealt with the issue raised under the second head of reference, and shown the finding of the Commission to be that the water supply is "of a very high standard of excellence and purity, and that it is suitable in quality for all domestic purposes."

Inquiry into the fourth head of reference was rendered unnecessary because the Commission had found that sufficient water can be obtained from the present sources of supply to cover the requirements of London for the forty years which they took into consideration.

It might have been expected, after the valuable and exhaustive report of Lord Balfour's Commission, that the question of the London water supply might have been allowed to follow the recommendations of the Commission for many years to come. Such, however, was not the opinion of the County Council. They had asked for the Commission, apparently, in the hope and expectation that they would curse the companies, and, "Behold they had blessed them altogether."

In 1894 the Council instructed their engineer to report "on the site and yield of other sources of water supply, and as to the method which might be adopted for considering and supplying water to London with estimates of cost." Sir Alexander Binnie's report, dated June 8th, 1894, describes a scheme for constructing large storage reservoirs for impounding the waters of the rivers Usk and Wye, aud several tributaries, and bringing the water so collected to London by two aqueducts about 160 miles in length. The quantity of water to be provided from a catchment area of 488 square miles, with a rainfall varying from 45 to 70 inches per annum, was 415,000,000 gallons a day, to be delivered into reservoirs at Elstree and Banstead, at a total cost of £38,772,000. Sir Alexander Binnie proposed to construct the works in two instalments, the first to bring 182,000,000 gallons daily to Elstree, at a cost of £17,500,000, to be supplemented by the Edw with 18,000,000 gallons additional, or a total of 200,000,000 gallons daily, at a cost of £18,095,250.

The second instalment to be made at a later date would complete the total supply of 415,000,000 gallons daily, at a total cost of £38,772,280, as before stated. If to this quantity be added 67,000,000 gallons daily available water from chalk wells near London, a total supply of 482,000,000 gallons daily would be obtained, sufficient for the wants of a population of 13,800,000, or down to the year 1943.

Fortified with this report the County Council have opposed all legislation based upon the report of Lord Balfour's Commission. Their opposition had previously caused the defeat of the East London Company's Bill of 1893, and by postponing works which the engineer of that company declared to be necessary, had directly contributed to the scarcity of water in East London in 1895 and 1896. The Council have since opposed storage schemes brought in by the separate companies, the Staines Reservoir Companies promoted by the West Middlesex, Grand Junction, and the New River Companies in 1896, and the storage reservoirs proposed by the Southwark and Vauxhall Company in 1898. These schemes have, however, received Parliamentary sanction. The County Council have, moreover, opposed before the present Royal Commission the scheme brought forward to safeguard the supply of every district of the metropolis by making suitable connections between the works of the companies.

In 1897, the Government constituted a Royal Commission, with Lord Llandaff as chairman, to inquire, "whether it is desirable, in the interests of the ratepayers and water consumers in the districts of supply of the metropolitan water companies, that the companies shall be acquired and managed either (*a*) by one authority, or (*b*) by several authorities, and, if so, what should be such authority or authorities," and other subsidiary questions.

This reference has indirectly raised the question, whether the policy of the County Council to bring water from Wales, or that of the companies to develop the present sources of supply, is the more advantageous to the ratepayers and consumers.

Notwithstanding the fact that the question of the metropolitan supply was being considered by the Commission, the County Council

have endeavoured to forestall any recommendations which it may make by promoting Bills in the present Session of Parliament for the purchase of the companies' undertakings, and for carrying out the first portion of their Welsh scheme, as proposed by Sir Alexander Binnie, but slightly modified in accordance with the suggestions made by Sir B. Baker and Mr. Deacon in a report which they have given to the Council upon a reference made to them. Judging by this report, and by the evidence given before the Royal Commission, the County Council appear to have abandoned their original statement, that London water is clarified sewage, unfit for potable purposes, as they are content to accept as a permanent supply the 185,500,000 gallons daily, which the companies now have powers to take from the Thames.

Now, in considering the policies of the County Council and of the companies, it must be remembered:—First, that, as previously shown, the water, as supplied to London, is "of a very high standard of excellence and purity, and suitable in quality for all household purposes."

Further, the late Mr. Hawksley showed from the health statistics of many towns in England that those which are supplied by river water are generally more healthy than those supplied from a mountain source.

That, secondly, it must also be remembered that the total supply to be obtained under the Welsh scheme is 415,000,000 gallons daily, which, upon the usual proportion, would give about 553,000,000 gallons daily as the total yield of the reservoirs.

On the other hand, the Thames possesses an average flow of 1,300,000,000 gallons daily upon a cycle of years.

It seems absurd, therefore, to leave a larger and equally good supply, obtainable close to London, for another supply from a distant source, unless and until the expense of developing the larger becomes greater than that which would be incurred in utilising the smaller and distant supply. For see what would happen. After exhausting the capacity of the Welsh supply it would be necessary to revert to the present sources, which the promoters of the distant scheme now affect to despise.

The question therefore resolves itself into the comparative cost of the two schemes. It would be impossible for me in the time at my disposal this evening to present to you all the figures and estimates which my friends, Sir Alexander Binnie on the one side and Mr. R. E. Middleton on the other, have, with marked ability and untiring industry, laid before the Royal Commission. Their views can be read at length in the minutes of evidence taken before the Commission. I purpose, therefore, to lay before you the figures at which, after mature consideration, I have myself arrived, which have the advantage of lying between those for which the two engineers referred to are responsible. My results, however, are much nearer Mr. Middleton's than Sir Alexander Binnie's, as they are based upon the same estimates of the Welsh scheme by analogy with the cost of the Thirlmere works for Manchester, the Vyrnwy works for Liverpool, and the Elan works now being constructed for Birmingham. Until the surveys, drawings, and bills of quantity are prepared, the land scheduled and detailed prices worked out, I am of opinion, with Mr. Middleton, that the estimate by analogy with the cost of works carried out by some of the ablest engineers of the day, is by far the more reliable method of arriving at the cost of the Welsh works.

In regard to the Thames scheme the case is different. We know the exact price of the present works as let to the contractors; we know the prices paid for the land, and the working of an estimate is perfectly simple and must be accurate.

In making the comparison between the cost of the two schemes, I have endeavoured to hold the balance equally and fairly between them, the result being shown in the following Table:—

Summary of Cost of Welsh and Thames Schemes at 1916, 1920, *and* 1936, *the dates at which further supplies will be required.*

Welsh Scheme.

Estimates W. H. 1 *and* 2.

By analogy from cost of Thirlmere, Vyrnwy, and Elan Valley Works.

First quantity, 121 million gallons daily supply, 1916 or 1920.

Second quantity, 93 million gallons daily supply, 1936

Daily supply.	Cost of works.	Interest during construction.	Capitalised pumping charges.	Total.
million galls.	£	£	£	£
121	20,600,551	3,190,150	87,747	21,878,44
93	12,112,314	1,092,888	85,515	13,290,71
	£32,712,865	£4,283,038	£173,262	£37,169,1

THAMES SCHEME.

Estimates W. H. 2 and 3.

Under conditions of 1898, minimum flow 100 million gallons at Teddington.

First quantity, 121·5 million gallons daily supply, 1920.
Second quantity, 93 ,, ,, ,, 1936.

Daily supply.	Cost of works.	Interest during construction.	Capitalised pumping charges.	Total.
million galls.	£	£	£	£
121·5	4,483,000	559,717	2,992,537	8,035,254
93	4,309,670	543,190	2,610,997	7,463,857
	£8,792,670	£1,102,987	£5,603,534	£15,499,111

THAMES SCHEME.

Estimates W. H. 6 and 7.

Under conditions of 1898, minimum flow 200 million gallons at Teddington.

First quantity, 121·5 million gallons daily supply, 1916.
Second quantity, 93 ,, ,, ,, 1936.

Daily supply.	Cost of works.	Interest during construction.	Capitalised pumping charges.	Total.
million galls.	£	£	£	£
121·5	6,773,930	1,404,719	2,741,026	10,919,675
93	5,039,920	632,933	2,680,278	8,353,131
	£11,813,850	£2,037,652	£5,421,304	£19,272,806

THAMES SCHEME.

Estimates W. H. 8 and 9.

Under conditions of 1893, minimum flow 200 million gallons at Teddington.

First quantity, 121·5 million gallons daily supply, 1916.
Second quantity, 93 ,, ,, ,, 1936.

Daily supply.	Cost of works.	Interest during construction.	Capitalised pumping charges.	Total.
million galls.	£	£	£	£
121·5	5,340,710	943,673	2,732,868	9,017,251
93	5,248,790	674,235	5,687,204	8,610,229
	£10,589,500	£1,617,908	£5,420,072	£17,627,480

It is fair to say that the Thames estimate, and under the conditions of 1898, would be slightly increased, as the estimates were made in November, and would in no way alter the estimate under the conditions of 1893.

It will be seen from the above Table that the cost of the Welsh scheme for the supply of the same quantities of 121·5 and 93 million gallons daily, will be in round figures from 2 to 2½ times the cost of the supply of the same quantity by the Thames scheme, dependent upon the minimum flow fixed at Teddington.

The above quantities added to the 185½ million gallons already authorised, provided for a total quantity of 400 million gallons daily being taken from the Thames, sufficient with the water available from the Lea and wells in the chalk for the supply of the metropolis to the year 1948, supposing that the population should in the meantime increase in accordance with the figures accepted by the Balfour Commission. There will therefore be no necessity even to consider any question of increased draught from the Thames or the provision of water from an outside source, for at any rate the next forty years. It is possible, and, indeed probable, as has already happened, that the population will not increase in anything like the same rate as in the decade from 1881 to 1891. The adaptability of the Thames scheme to meet such a contingency is one of its most valuable features. The storage reservoirs contemplated under it need only be constructed as the actual increase in the population renders them necessary. Should the population increase at a slower rate than estimated, the work could be retarded until they are actually required. On the other hand the larger part of the expenditure upon a supply from distant sources must be incurred at the outset and may eventually be found to have been undertaken upon too large a scale, laying unnecessary financial burdens upon the ratepayers and water consumers. I would remind you that there is no record in ancient or modern times of a city containing 12,000,000 inhabitants.

It is impossible within the scope of a paper like the present to enter into all the arguments for and against the purchase of the companies' undertakings by the County Council, and it is no doubt undesirable to discuss this question in detail at the present moment when the whole subject is being considered by the present Royal Commission. It is, however, necessary to remember that any purchase to be fair must take into consideration prospective, as well as present, profits and liabilities, and therefore cannot be a source of profit to the purchaser. And further, that the County Council are pledged to the Welsh scheme, which, as has been shown, must result in heavy additional expense as compared with the development of the present source of supply. In addition the County Council will have to provide a sinking fund to pay off the capital sum within a certain fixed period which will entail heavy addition at cost upon the water consumers of the present and next two generations for the benefit of posterity. The foundation of the greatness of Britain is private enterprise. The reward which successful enterprise brings is the great incentive to

the ablest men of each generation to apply their powers to advance the general knowledge and add to the comfort, convenience, and happiness of mankind.

Municipalisation tends to discourage private enterprise, and to fasten the socialistic ideas now popular with a certain school of politicians, the triumph of which will, in my opinion, be the commencement of the decadence of England.

On these grounds I am opposed to the municipalisation of the water companies unless a clear gain to the community is to be the result.

I believe that I have shown that the policy of the London County Council will result in a heavy loss to the consumers and ratepayers. Therefore, I am of opinion that the adoption of that policy would be detrimental to the public interest.

On the other hand, the water companies have shown by the excellent manner in which they have fulfilled their obligations, by their joint action this year in combining to secure the supply of every district of the metropolis, and by the declaration of their readiness to be under all circumstances responsible for the provision of an ample and satisfactory supply of water, that they are worthy of the position which they hold, and that they deserve the continued confidence of the community.

I desire, in conclusion, to express my thanks to my colleagues, the engineers of the companies, for the information and drawings which they have furnished to me, and to Mr. Mansergh, V.P.Inst.C.E., for kindly lending some of the lantern slides which have been shown upon the screen. My acknowledgments are also due to Dr. Sisley and Mr. Arthur Shadwell for their excellent books on "The London Water Supply" from which I have given quotations in this paper.

DISCUSSION.

The CHAIRMAN said the word water implied a cooling drink, but curiously enough when the word "supply" was added to it, people generally get warm, and if you prefaced this by the word London, the temperature rose almost to boiling point. The question of the London water supply generally gave rise to hot discussion; but after all it was a good thing for great questions like that to be well fought out, for there was no way of arriving at the truth so certain as a thorough discussion, especially in scientific and engineering matters. But however different their views might be as to the means, the object of all, whether the advocates of municipal management or of private enterprise, was to get a good supply of water for London. It was sometimes said that the London County Council or some other Corporation wanted to confiscate private property; but whether they wanted to or not, he was quite sure they would not succeed, for Parliament would never hand over a company which was doing its work properly to a Corporation without making the Corporation pay uncommonly well for the bargain. If a trading company was not doing its duty to the public, of course it was another matter altogether. Again, it was said on the other hand, that a company was only a trading body, and its prime interest was the profit of the shareholders; assuming that to be so, no company could succeed which supplied a bad article. Even the warmest advocates of municipal control would allow that in this country companies had done their work uncommonly well; and certainly in one thing the London water companies had done well. They had taken good care to have the best engineers they could get, and they had been very well served by those engineers. The London water supply was peculiar in this respect that he did not think there was any other part of the kingdom in which it would be possible to get a supply for a large city like London, right in the middle of a river valley. No one would attempt to get such a supply from the Severn, or any of the other large rivers. The Thames happened to be a good river, where you could get intakes at all events not very much polluted, if at all. Of course there was always a risk of pollution to some extent, and the London water companies would have that risk, but they were not simply water-getting companies; they were manufacturers: they had to treat the water to deprive it of any harmful properties it might have, and to send it out in a proper state for consumption. From that point of view the effects they produced were very wonderful, effects which were never dreamed of when sand filter beds were first thought of. It was now known that the surface layers of sand on which a slight organic film formed actually purified the water bacteriologically and destroyed the most injurious contents. The paper divided itself into two heads, first, the historical portion, which might have been treated at much greater length had time allowed; and, secondly, it dealt with more controversial matter—what water should be got and whom it should be got by. Those were subjects he would leave the meeting to discuss; he had always avoided them, because he was a man of peace, but he hoped they would be taken up by others. It was certain that a great city like London could not get on without a good water supply, and the larger the supply you required the more difficulty there was, and the difficulty increased at a greater rate than the quantity. Large expenditure therefore must be faced, whether by companies or by public authorities. Those who opposed the companies would probably allow that they had done their best to improve the supply

That they had made mistakes went without saying; they were but human, but when the mistakes were pointed out they did their best to set them right. It seemed a curious thing to him that there should be eight different companies supplying London, and he should like to see them joined up. He was told there were great difficulties in the way, and no doubt there were; the companies were constituted under different Acts. They had different organisations, and different methods of work; but if they could join together there would be a great economy in many ways. In the first place, there would be a saving in mains; in many streets there were two independent sets of mains, and perhaps three in some; and there was a story that in one the inhabitants for several years got their water from one company and paid rates to another. Another peculiarity of the London supply was the variety of the sources from which it was derived. He did not refer to the Thames and the Lea, which were for practical purposes two parts of the same river, but a much larger quantity than most people were aware of was obtained from wells—quite enough to supply any other town in the kingdom. The Kent Company obtained its whole supply from wells, but the New River and the East London both got a good deal, and the Southwark and Vauxhall a certain amount from wells. Many other companies had tried experiments, for which as a geologist he was very grateful, with regard to getting water from great depths. They were mostly futile as far as regards very deep supply, but they obtained a good deal of water at intermediate depths which had sometimes repaid the cost, and they had given scientific men a deal of information which they would not otherwise have had, and which may prove of great economic value.

Mr. J. W. Restler (Southwark and Vauxhall Co.) said there was one point which he thought might have been even more emphasized. It had been held out to the ratepayers that there would be a great saving to them if the water companies were transferred to the London County Council, but as had been pointed out any purchase would have to be made on the basis of the present and prospective value, so that any future profits would be discounted. On the other hand, if the companies were left alone, part of the future profits must come back to the ratepayers after 10 per cent. was earned, which was now practically obtained by all the companies. Any extraordinary expenditure, however, for new sources of supply, or additional reservoirs, would have to be paid for out of the pockets of the shareholders.

Mr. R. F. Wheeler asked how it was there was such a famine in the East-end of London last year if the supply of water was as abundant as the author indicated.

The Chairman said he had rather to complain of Mr. Hunter for not including the Croydon Water Works in one of his lists, because they were rather proud of them. He also thought the New River began not at Chadwell Spring, but a little higher up. He could say a good deal about Chadwell Spring, which, when he last saw it, looked very different to what had been shown in the photograph. He saw it in company with Mr. Francis last autumn, when it was at its dryest, and he was surprised to find it so dry, even with that extreme drought. It was a hole 20 ft. deep, and though it was not really dry, it had fallen below the level at which it overflowed. No living person had ever seen it so low. The New River Company did not know what the bottom of it was like, and he was rather glad they had the opportunity to clean it out. Although a chalk spring, it was very cloudy, there being hills all round of drift gravel, sand, and loam, and no doubt some of the finer particles were brought in very quickly after rain, as was the case with other springs in that part of Herts. It generally yielded 3,000,000 or 4,000,000 gallons a day to the New River. He should also rather take exception to the statement in the paper quoted from Mr. Shadwell, that if the municipal authorities took over the supply the rates must necessarily be equalised. He did not see that it was at all necessary; corporations were just as likely to have vagaries in the matter of rates as water companies. Mr. Hunter also referred to the exhaustive report of Lord Balfour's Commission, but he did not think that was quite a correct term, because there had been another Commission since, and probably there would be another again. They had been going on from time to time all his life, and he expected they would continue. The late Mr. Thomas Hawksley had remarked that towns supplied by river water were generally more healthy than those supplied from mountain sources, but it did not necessary follow that that was the effect of the water. Health statistics were very difficult to deal with, but it might well be that most of the towns supplied from upland sources were manufacturing towns in the north in which the population was not so healthy as towns in the south which were supplied from rivers. He was sorry the water companies did not propose the junction scheme earlier, but no doubt it was a step in the right direction. It would prevent such a thing as happened last year when the company which wanted the largest supply ran short. He did not think the term water famine was quite accurate, because the supply at the lowest was at the rate of 25 gallons per head per day, which in many places would be an ample supply. He could not help thinking that a lot of water was wasted in London, and that there might be a good deal of saving which would make the available supply go much further than it now did. Where the waste occurred, he did not know, bnt it was worse probably in the poorer districts where the people could not be made to understand the value of water, and the care which ought to be exercised not to waste it. In future, those who had more than they wanted would be able to supply those who had less. That

was the principle adopted in rating, the richer parts helped the poorer, and on the whole it was right that it should be so. The Chelsea Company had power to take more than they would ever want, as their district could not increase, and the population might even decrease. It was to be hoped that these steps would get rid of any such temporary differences as occurred last year, which were very unlikely to occur again, at any rate, for a long time, for the circumstances were most exceptional, not in London only, but in many other places, where the question of restricting the supply had to be considered.

Mr. HUNTER, in reply, said there was no doubt the shortness of the East London supply last year—which, after all, was a very good supply—was due to the unprecedented drought. The rainfall was 2½ inches less than in any year of the 82 during which records had been kept at Greenwich. It deceived not only ordinary engineers, but the engineer of the London County Council, for he said, in 1897 or 1898, that he considered the East London Company had plenty of storage. They could only judge of the present and future by past experience, and it would be very uneconomical to allow a greater margin than appeared sufficient. Now, the companies themselves proposed to link up their various works in the way which commended itself to the Commission, and were now spending over £100,000 upon it, from which the shareholders could not get 1d. of dividend, simply with the view of inspiring confidence in the consumers, and to show that the companies did really intend to safeguard the water supply of all parts of the metropolis. No one was more anxious to fulfil the obligations laid upon them than the directors and officials of the water companies, because they knew that in so doing they were serving the best interests of the companies themselves. With about 870,000 consumers, the serious complaints might be reckoned on the ten fingers, which he thought spoke volumes for the efficiency of the administration. The statistics, and the evidence of entirely independent witnesses, showed how they had succeeded in giving an admirable supply as regards quality; the quantity had been ample hitherto, and now that the whole of the districts were to be linked together, it would be ample in the future.

The CHAIRMAN then proposed a vote of thanks to Mr. Hunter, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

THE VANILLA BEAN IN MEXICO.

The State of Vera Cruz has been considered the home of the vanilla, but recent developments show that vanilla can be cultivated in the State of Tobasco and on the Isthmus of Tehuantepec. The true home of the vanilla, where it flourishes the best in its wild state, is a narrow strip about 30 miles wide, 5 miles from the coast, and 90 miles long. The upper end of this strip is about 50 miles south of Tampico, and extends along the coast 90 miles towards the city of Vera Cruz, the bottoms along the Tuxpan, Casonez, and Nautla rivers, and the creeks contiguous, constitute the richer parts. Here the cultivated varieties yield most without artificial fecundation, either on account of the number of wild bees in the locality or by self-pollenation, which some claim as impossible. The United States Consul at Tuxpan says that artificial fecundation must be practised in order to produce the beans in commercial quantities. The vanilla plant is a vine of a bright green colour, with a smooth, waxy, transparent bark. It has a thick, waxy-looking leaf, light-green in colour, 6 to 9 inches long, 1½ to 2 inches wide, and sharply pointed. The vine reaches out tendrils which cling tightly to its tree support, but do not, as some believe, draw nourishment from the tree. The best time to set out the vines, or rather cuttings, is in April or May. The cuttings are the vines divided into lengths, usually 2½ to 3 feet long. Some of these can be cut in two according to the number of joints. Two to three joints are sufficient to put under the ground, with the same number of joints above ground. The joints are easy to propagate, in fact they are hard to kill if kept from being bruised. A cutting can be kept in the house on a dry shelf, and will live for months with scarcely any apparent change. In making a vanilla plantation much depends upon the selection of location. The first thing is to have the plantation where the pilfering of the beans while ripening can be prevented. A vanilla plantation need not be large; a few acres, with care and proper fecundation, will soon produce excellent results from a monetary point of view. Patient care and attention at the proper time is the chief secret of success. The vine requires rich soil, heat, ventilation, shade, and moisture. Rich pockets of land along the creeks and river bottoms are best. A profusion of wild vines of all kinds growing into a jungle, with abundant loose soil affording ventilation at the roots, is the best proof of the adaptability of the land. The land should be free from sand on account of drought, and free from clay, which would cause the vines to rot during the rainy season. There should be plenty of small trees, at the feet of which the vines can be planted. Trees which have smooth bark, and which never shed their bark or leaves, and grow to be no longer than 2 to 4 inches in diameter and from 7 to 10 feet high, are best for this purpose. Usually a variety of such grow on all wild lands, and any of them are good if the trunk of the tree be smooth, with plenty of sap. A small orange tree affords a good trunk for vanilla to grow to. If, while clearing the land, there be not enough of such trees found already growing, to plant the desired number of vines (there should be from 1,500 to 2,000 vines to the acre) enough should be planted, selecting the kinds tha

make the most rapid growth, which exist in abundance, and are destroyed by the thousands in nearly every new clearing of land. The ground should be kept clean from weeds. All undergrowth should be thrown around the vines to decay, and serve as manure for the roots. The ground around the roots should not be disturbed. One or two vines should be planted to each tree, and tied at first to the trunk with some flat, flexible band, such as strips of cocoanut leaves or plantain fibre. Round cord should not be used, as it is liable to cut and injure the green, succulent stem of the vine. Live stock are never permitted on a vanilla plantation. The stems and roots of the vine are disturbed as little as possible. The vine needs no cutting or pruning, and all other wild vines are cut out and kept from choking the vanilla vines. The trees should be topped to prevent too high a growth, so that the flowers can be reached from the ground. Light and ventilation beneath, shade from the sun above, rest and plenty of moisture—but free from standing surface water—are the prime requisites for the growth of vanilla vines. One peculiarity of the vine, is that after three or four years planting, the stem will rot off at the roots, and continue to rot three to four feet up the vine, while the top looks green and flourishing. In the meantime, from above where it is going to rot, it shoots out fine little rootlets like threads, and continues them to the ground. So delicate are these threads running along the trunk of the tree, and so prominent the rotted-off end of the stem, that it gives the vine the appearance of living independent of the earth, thus giving rise to the theory that it is an air plant. It will sustain itself in a severed state, but to make material growth and fruitage it must connect it e'f with mother earth. The new vine will commence bearing the third year from planting, and full crops may be expected the fifth year. A vine will bear from 15 to 45 beans a year. Some vines have been known to produce as much as 65 beans at one time. Twenty beans to a vine is a good average. Rarely do those who grow the beans cure and market their crops. Some buy the green beans and make a business of curing and exporting them. Consul Jones says that judging from the way they all get rich at the business, and the difference between the price at which they buy the green bean and the price at which they sell the cured, there must be more profit in the curing than in the growing. Still, in view of the price of vanilla, and the demand for it all over the world, there are large profits for both parties. Wild lands suitable for vanilla can be bought for from £1 to £2 per acre. There are vanilla-producing plantations in the vicinity of Papantla that could not be bought for £100 per acre. Various estimates have been furnished as to the cost per acre of converting wild lands into vanilla-producing plantations. Approximately, £17 an acre is correct, which is very moderate for so profitable a plant. The greater part of the vanilla in the district of Tuxpan is grown about Papantla, much of which is exported from Vera Cruz, it being easier to reach Vera Cruz by water than Tuxpan by land. The two busy seasons of the year are during the pollenation months—March, April, and May, and the gathering months—November, December, and part of January. During the balance of the year the plantation should have absolute rest, other than keeping down the weeds and undergrowth. Many of the beans are gathered in October, sometimes before they reach their growth, by those who see an opportunity of gathering them unknown to the owner, or by the owner, for fear of losing them, because he has not his vines where he can watch them. Beans gathered too soon are woody and inferior in quality, lacking the oil that furnishes the flavour. Good ripe beans lose but little of their weight while curing; 5 lbs. of green beans will weigh $4\frac{1}{2}$ lbs. when cured. The quality and flavour are increased by allowing them to mature and by the proper curing. The curing is principally done by Spaniards who have followed this business. The process adopted is slow and laborious. The secret is to evaporate the water while retaining the oil, and to take care not to injure the flower. Vanilla is principally exported from Mexico to the United States—about £400,000 worth annually.

General Notes.

THE ELECTRIC LIGHT AT THE SOCIETY'S HOUSE.—Arrangements have been made to connect the Society's electric installation with the street mains, and therefore the machinery and apparatus used since the electric light was first installed in the Society's house in 1883 are now no longer required. It is proposed to offer them in the first instance to any member of the Society who may be contemplating an electric installation in the country. Particulars of the apparatus available will be found in the advertising columns of the *Journal*.

ST. PETERSBURGH HORTICULTURAL EXHIBITION.—Further information respecting this third International Exhibition of Horticulture, to be opened at St. Petersburgh, has been received from the Science and Art Department. A second supplement to the programme of the Exhibition has been published, which contains a supplementary list of prizes, with a list of the Foreign delegates, and the constitution of the Foreign Section of the Exhibition.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

APRIL 26.—"Coal Supplies." By T. FORSTER BROWN. W. BOYD DAWKINS, F.R.S., will preside.

MAY 3.—"Ætheric Telegraphy." By W. H. PREECE, C.B., F.R.S.

MAY 10.—"Fruit Growing in Kent." By GEORGE BUNYARD. SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., will preside.

MAY 17.—"The Law of Trade Marks." By J. E. EVANS-JACKSON.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 27.—"Judicial Reform in Egypt." By Sir JOHN SCOTT, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. The Khedive. The LORD CHIEF JUSTICE OF ENGLAND, G.C.M.G., will preside.

MAY 11.—"The Revenue System and Administration of Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar and Bhurtpore. Colonel GEORGE HERBERT TREVOR, C.S.I., will preside.

JUNE 1.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal. The EARL OF ELGIN AND KINCARDINE, K.G., G.C.S.I., G.C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MAY 2.—Mr. Burton's paper on "Maiolica," announced for this evening, is unavoidably postponed.

MAY 16.—"The Artistic Treatment of Picture Frames." By I. HUNTER DONALDSON.

MAY 30.—"The Revival of Tradesmen's Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

PROF. HENRY R. PROCTER, F.I.C., "Leather Manufacture." Four Lectures.

LECTURE II.—APRIL 24.

Removal of hair and wool—The staling process—Bacteriological and chemical actions involved—Depilation by lime—Practical methods—Chemistry of liming process—"Buffalo" method—Pullman's indirect process—Use of alkaline sulphydrates—Realgar—Mechanical operations—Deliming processes—Chemical and physical considerations—"Pulling down" with acids—Fermentative methods—The bran drench—Bating and puering.

LECTURE III.—MAY 1.

Physics of tanning—Theory of the pickling process—Mineral tannages—Tawing with alumina salts—Chrome tanning—Heinzerling process—Schultz or "two-bath" process—Basic or "one-bath" process—Iron tanning.

LECTURE IV.—MAY 8.

Oil dressing—The chemistry of the process—Combinations of oil and mineral tanning—Vegetable tanning matters—Chemistry of the tannins—Practical methods—Combination of vegetable and mineral tanning—Currying—The chemistry of oils and fats used—Theory of the currying process.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Henry R. Procter, "Leather Manufacture." (Lecture II.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. George Beilby, "The Relations of the Society to Chemical Engineering and to Industrial Research."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. C. Jones, "Scavenging Disposal of House Refuse, &c."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn Hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Antiquaries, Burlington-house, W., 2 p.m. Annual Meeting.

TUESDAY, APRIL 25...Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. Cossar Ewart, "Zebras and Zebra-Hybrids." (Lecture III.)

Medical and Chirurgical, 20, Hanover-square, 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

Photographic, 12, Hanover-square, W., 8 p.m. Mr. Thomas Bolas, "A Demonstration of the Making of Glass Diaphragms—thin to Newton's 'very black' stages."

WEDNESDAY, APRIL 26...SOCIETY OF ARTS, John-street, W.C., 8 p.m. Mr. T. Forster Brown, "Coal Supplies."

Geological, Burlington-house, W., 8 p.m.

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. Alfred East, "Some Aspects of the Art of Hokusai."

Royal Society of Literature, 20, Hanover-square, W., 4½ p.m. Annual Meeting.

British Astronomical, Sion College, Victoria-embankment, W.C., 5 p.m.

THURSDAY, APRIL 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir John Scott, "Judicial Reform in Egypt."

Royal, Burlington-house, W., 4½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. R. Cameron, "The Growth of Art in our Public Schools."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Atmosphere." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Messrs. W. Duddell and E. W. Marchant, "Experiments on Alternate Current Arcs by Aid of Oscillographs." 2. Mr. J. Elton Young, "Capacity Measurements of Long Submarine Cables."

Hellenic Society, 22, Albemarle-street, S.W., 5 p.m.

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 7½ p.m. Address by the President, Sir William White.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Rev. J. M. Bacon, "Aerial Research."

Anthropological, 3, Hanover-square, W., 8½ p.m.

FRIDAY, APRIL 28...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. C. A. Carus Wilson, "Some Features of the Electric Induction Motor."

Mechanical Engineers, Storey's-gate, St. James's-park, S.W., 7½ p.m. Mr. H. G. Oldham, "Evaporation Condensers."

Clinical, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 4 p.m. Annual General Meeting.

SATURDAY, APRIL 29...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Louis Dyer, "Machiavelli." (Lecture III.)

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FRIDAY, APRIL 28, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 24th instant, Professor Henry R. Procter, F.I.C., delivered the second lecture of his course on "Leather Manufacture."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday, April 27, 1899; the Lord Chief Justice of England, G.C.M.G., in the chair.

The paper read was on "Judicial Reform in Egypt," by Sir John Scott, K.C.M.G., D.C.L., Deputy Judge Advocate-General, and late Judicial Adviser to H.H. the Khedive.

The paper and report of the discussion will be published in a future number of the *Journal.*

PRACTICAL EXAMINATIONS IN MUSIC.

The Practical Examinations in Vocal and Instrumental Music will be conducted by Mr. John Farmer, Balliol College, Oxford, and Director of the Harrow Music School, Examiner, and Mr. Ernest Walker, M.A., Mus.Doc., Oxon, and Mr. Burnham Horner, Assistant Examiners, at the House of the Society, and will commence on Monday, 26th June.

The last day for receiving applications is Saturday, 12th May.

Particulars can be obtained on application to the Secretary.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, April 19, 1899; John Sparkes in the chair.

The Chairman, in opening the meeting, said that he regretted to have to announce that Mr. Webb was too unwell to attend the meeting, and that the paper would therefore be read by the Secretary of the Section.

The paper read was—

INTARSIA.

By Stephen Webb.

Intarsia, or inlays of wood, ivory, &c., one of the most interesting of the so-called "minor" arts, has probably suffered more both from its neglect and from its abuse than any other method of decoration. At its best—kept within its proper limitations—no more delightful form of decoration was ever devised. One must, however, be confronted with a bad example in order to be able to realise how bad it can become at its worst.

Probably every existing form of art or craftsmanship has at some period of its development suffered through the ultra-cleverness of its exponents. In painting, at the present time technique (especially in France) is worshipped for its own sake, and what we think should be only regarded as a means of expression is set before the student as the end to be attained. Intarsia, like every other art, is at its best when most itself, but, except in the earliest periods of its development, its students and makers were never able to resist the temptation to wander out of their proper limits in imitation of other arts. The reasons of the very earliest designers and craftsmen for keeping simple and pure in their designs and patterns did them little credit, as they were probably merely mechanical reasons, and arose out of the difficulty of producing elaborate work by the only methods known to them at that time.

To a designer who has taken the thing up in the right spirit, and who has gone to the trouble of making himself even tolerably well acquainted with the resources of the craft, it would appear incredible that any one should consider it necessary to go outside its proper limitations in order to imitate any of the sister arts. The materials are so beautiful in themselves, so infinitely varied, and so adaptable to his purpose, that, assuming him to possess even a

small measure of artistic instinct, his work is really half done to his hand before he draws or cuts a line. The decorative problems which present themselves to the worker in intarsia for solution are few as compared with those of the painter or sculptor. For example, he has not to concern himself with surface technique at all. Tone, harmony, and, in a limited degree, the sense of values, he must certainly cultivate. He must also be able to draw a line or combination of lines which *may* be ingenious if you like, but *must* be delicate and graceful; vigorous withal, and in proper relation to any masses which he may introduce into his design.

He must thoroughly understand the value of contrast in line and surface form, but these matters, though a stumbling block to the amateur, are the opportunities of the competent designer and craftsman—if by good hap the designer is in a position to be the craftsman also. The most charming possibilities of broken colour lie ready to his hand to be merely selected by him, and introduced into his design; and yet, with these and other advantages peculiar to work in this kind, the whole history of the art, so far as I can follow it, except in the earliest times, is a story of perverted ingenuity, the story of an art degraded more than any other by the perverseness and want of taste of its votaries. Surely in no other art has the clever, sometimes exquisitively clever, craftsman suffered so many things from the bad or perverted taste of the designer. Whether the craftsman has been his own designer or has worked from the drawings of another, is all one; and it makes one marvel to find the most consummate technical skill so frequently associated with that which is worst in taste and in composition.

I do not know the precise date at which the use of veneer for furniture became general, but I have little doubt that what may be termed the "fatal facility," which this afforded to the craftsman, must have suggested the over elaboration which had been practically impossible through the limitations imposed by the earlier methods. The earliest examples of inlaid work, viz., those in which the ground is cut away and the pattern inserted into the solid wood will nearly always be found to be good of their kind. The work, from its nature, could only be done at the cost of much time and labour, and this, doubtless, suggested to the executant the necessity for the elimination of everything from the design which was not absolutely necessary to the development of the motive, a condition of things which always makes for good decorative art in any material.

I doubt not that the early workers in intarsia often wrought, as the old builders are said to have sometimes builded "better than they knew."

With the introduction of veneers or skins of wood came a complete change. The economical necessity for the reticence hitherto observed was removed, the smallest details could be introduced into a design with comparatively little difficulty or cost. Wooden pictures began to replace the former pure and appropriate decoration. All reserve was apparently thrown aside, and the tarsatoir of the period revelled in the representation of temples, gardens, figures in extravagant costumes with wooden bodies and sometimes ivory heads or faces, and so the triumph of craftsmanship and the decadence of design may be followed through their various developments. In these the artist appears to have done his best (or worst) to outdo his predecessor or contemporary worker in the extravagant use of forms, proper only to the painter or picture maker, till it touched what was, perhaps, its highest point of absurdity in the wooden representation of whole towns, castles, &c. We see these illustrated in the German work of the 18th century on panels used chiefly for the interior decoration of cabinets.

The French work of the 18th century is every whit as extravagant as that of Germany in another way. There is a small table in the Jones collection at the South Kensington Museum, the top of which is decorated with "Boule work (metal and ivory). In the plan of the decoration a band is used into which—and on which are introduced figures in the costume of the period—curiously scalloped cloths, tassels, foliated forms, pateræ, Caryatides—monkeys, squirrels, swags of flowers, baskets of flowers, masks, birds (cranes), dogs, festoons formed of petals or husks, cornucopiæ, and probably a few other properties more or less material to the scheme. If this kind of thing was ever worth doing (a matter about which I am hardly prepared to speak here), an excuse for it would surely be found in this table, which, as a piece of craftsmanship, apart from its design, is certainly one of the finest existing examples of this kind of work.

Personally, I have never been able to get up any enthusiasm for metal inlay for furniture. It is frequently very gorgeous, nearly always extravagant in design, seldom beautiful, and

even if one has the fortune to get a beautiful design, it is generally difficult to bring it into harmony with any colour scheme which may have been adopted for the decoration of the room.

Moreover, it is not easy to cut, though that is perhaps more a matter of time than difficulty, and it is apt to leave the ground when laid—which is a much more serious matter.

These are only mechanical difficulties. The chief trouble, and one which I confess I have never overcome to my own satisfaction, is in the selection of wood of a colour and texture which shall at the same time contrast agreeably with the metal surfaces and harmonise both with the metal pattern and the ordinary colours used in the decoration of a modern room. May I venture to recommend this problem to the notice of any of my *confrères* who have the requisite leisure and experience to attempt its solution. The thing has never been done yet.

In studying French—and indeed all other marquetry work of nearly every period—the superiority of the workmanship to the design is still constantly in evidence. In nearly every important example which remains, it is plain that the executant, so far from being guided by the designer, has been led out of his way, the obvious result being a deplorable waste of skilful craftsmanship.

Curiously enough this want of taste shown in the selection of forms suitable to the embellishment of furniture, is sometimes, and indeed often, found combined, in the same cabinet, with what one would fain believe to be evidence, that the designer had the colour scheme perfectly, and could select the woods suitable for his purpose, with the certainty of getting the effect which he had in his mind. But the almost inevitable introduction of these little bits of ivory again gives one pause, makes one doubtful whether the harmony of colour in the woods was not accidental, or the effect of time, as it would seem impossible that a designer, who had sufficient knowledge of the conditions necessary to produce so good a colour harmony in the woods, could deliberately bring himself to introduce anything so obviously disturbing to the whole scheme as these little bits of ivory always are.

It is not until the close of the 14th, or beginning of the 15th, century that we find intarsia used for the decoration of large surfaces, nor, indeed, till then, does it appear to have been taken seriously into the consideration of artists or its possibilities recognised. Then we hear that Brunelleschi and Paolo Uccello gave lessons in perspective and tarsia to architects and others, of which Masaccio, in his paintings, and Benedetto da Majano, in his inlaid works, availed themselves.

There are certainly to be found examples of the craft in the small ivory boxes, ornamented with inlay of various coloured woods, manufactured chiefly at Venice in the 14th century.

According to Vasari, one of the greatest names in the art is that of Fra Giovanni da Verona, who, in place of the dark and light woods of two or three tints only, used by the Majani, gave artificial colours to his wood inlay by means of waters, coloured infusions, and penetrating oils. To obtain brilliant high lights he was accustomed to use delicate slips of willow. F. Vincenzo dalle Vacche is mentioned by Morreli in his *Notizia* as excellent in such work, particularly in the church of San Benedetto at Padua. Fra Rafaello da Brescia, of Monte Oliveto, ornamented the choir of San Michele. Sabba Castiglione, in his "Ricordi overro Ammaestramenti" (1562), given in Digby Wyatt's essay on the subject, in "The Industrial Arts of the 19th century," mention the Legnaghi as good artists in this manner, and he speaks of the Dominican monk, Fra Damiano da Bergamo, the most celebrated of the 16th century followers of the art. "But above all, those who can obtain them, decorate their mansions with the works, rather divine than human, of Fra Damiano . . . who excelled not only in perspective, like those other worthy masters (Fra Giovanni and Legnaghi), but in landscapes, in backgrounds, and what is yet more—in figures, and who effected in wood as much as the great Apelles did with his pencil. I even think that the colours of these woods are more vivid, brilliant, and beautiful than those used by painters, so that these excellent works may be considered as a new style of painting without colour, a thing much to be wondered at. And what adds to the marvel is that though these works are executed with inlaid pieces, the eye cannot, even by the greatest exertion, detect the joints." Thus the worthy Messer Sabba Castiglione.

The colouring in this case was produced by chemical fluids, with the aid of burnt in shadows. Damiano's best work, in which he was assisted by Fra Antonio Asinello, of the same monastic order, are not in colour, but are assisted in their effect by burnt shadows.

Other works of his are mentioned by Lanzi, as in the Dominican Church at Bergamo, and in San

Pietro da Casinensi, Perugia. Gian Francesco Capo di Ferro is spoken of as working, also at Bergamo.

Other works in this manner are to be seen at the Certosa, Pavia, in the choir executed by Bartolommeo de Pola in 1486; in the choir of the Cathedral at Siena, by Fra Giovanni da Verona; in the Sacristies of San Miniato al Monte and Santa Croce at Florence, and in the Sala del Gambia at Perugia, the last being signed with the name of Marc Antonio Mereatelli. The tarsia work of artificially coloured woods which Sabba Castiglione so eulogises is not to be found in any of the above-named works, and although the practice clearly originated in Italy it reached its ultimate development in France and Flanders.

Probably the inlay which in its character most nearly approaches that of the Italian Damiano is the modern French work, so much of which is sent over to England in and for the decoration of pianofortes, &c.

It has nearly all the faults so conspicuous in Damiano, and where the modern Frenchman has missed any of the weaknesses apparent in the work of the Italian he has more than made up for it by those which he has invented for himself. Here is evident the same struggle to obtain the effect of painting, and an equal anxiety to conceal the joints which divide the various pieces of highly coloured woods introduced into the design. Indeed the French critic of marquetry in these days makes this joining the test for good or bad work, and were a panel of intarsia submitted to his judgment in which the mark of a saw could be seen the work would be at once condemned as bad though it exhibited all the finer qualities of design and cutting.

The experience of the writer is that the joinings of the various kinds of wood used in a design should not only not be concealed, but that they should be dealt with as frankly as possible, and that their utilisation in the design contributes almost more than anything else towards giving the work its character as intarsia or marquetry. It is true that the arrangement of the various pieces of veneer in a manner which will make the work of the cutter practicable and easy, and secure an artistic line for the joinings at the same time, calls for the exercise of some ingenuity, but this, though irksome and troublesome at first, soon becomes a habit with the designer for intarsia, or, at least, soon would do so if he understood its value. In nearly every example of modern work in which shading (generally produced by hot sand) has been resorted to, it has been abused. If the wood be properly selected, shading is rarely necessary, and if it is done at all it should be done by an artist. It can never be safely left to a merely mechanical cutter of marquetry, even though he works from the most carefully finished drawing. In the hands of an artist, very beautiful effects may be obtained by this process, the same kind of wood being made to yield quite a number of varying shades of colour of a low but rich tone, and that without any sacrifice of what, for lack of a better term, I must call the transparent quality, so characteristic of all good marquetry work. Overstaining and the abuse of shading is destructive of this, one of the most valuable and distinctive qualities in inlays of wood.

Ivory has always been a favourite material with workers in tarsia, and in the hands of an experienced designer, very charming things may be done with it. There is, however, no material suitable for tarsia which requires so much care and experience in its use. It is ineffective in light coloured woods, and in the darker ordinary woods such as ebony, stained mahogany or rosewood, under polish, the contrast of colour is so great that the ivory must be used very sparingly, in other words the designer must invent for his panel or border a pattern or design which, while containing very few elements, shall convey the idea of a satisfactory furnishing or filling (always a difficult problem for the designer to solve in any material). In work intended for many other processes and materials, every artist has, at times, to consider the advisability of some such treatment as this, but it is seldom that he finds it so absolutely indispensable to the success of his work as in the application of design to the inlay of ivory for furniture. This kind of work is improved very much by age (the effect of light chiefly) even under polish. The ivory is sometimes stained in order to bring its colour more into harmony with a dark wood ground, but it is never quite satisfactory, and no one who had seen much old ivory in tarsia could be deceived by it.

There are conditions possible where—particularly in the decoration of furniture—the advantages are nearly all on the side of intarsia as compared with carving or modelling. The amount of time wasted for instance on very small carvings in dark-coloured woods intended to be used in furniture is incredible. The colour of wood, such as mahogany, walnut, &c., makes it impossible to see small

carved detail in the various and varying conditions of light, which usually obtain in a living room, and when, as so frequently happens, rosewood or some other strongly-marked wood is used for this purpose, the markings in the wood are so much stronger than the shadows by which the small carved forms are expressed that their effect is destroyed, and the result must always be confusion and waste of time.

Very small detail, especially in carvings, is introduced much more frequently than is necessary in furniture, as in architecture, and its introduction may usually be taken as indicative of some confusion in the mind of the designer or architect between smallness and delicacy. This idea, that scale or minuteness of detail must somehow be related to refinement or delicacy, absurd as it would appear to be to an artist, must really be very common to the designers of houses and furniture, or we should not see so much skilful labour and valuable time wasted in such useless productions. In this, as in other matters, it is only the thought or design in the thing which really counts; no amount of mere slavish though skilful labour undirected can possibly result in anything but disappointment, and there must be a very plentiful lack of direction in some of the places where modern furniture is decorated. If small carved details mnst be introduced into the external decoration of furniture they can only be certainly effective when plain and light coloured wood is used, such as box, pear tree, &c., or quite black wood such as ebony (which has generally to be made black artificially), materials which have but little marking to disturb the surfaces and lines of the carving.

Undoubtedly, the colour of these would render them in many cases unsuitable for the decoration of furniture, as they are apt to prove disturbing to the quiet colour effect, generally associated with a living room.

It is here that inlay for the surface decorations can be made so useful in the solution of a difficult problem, when it is done with judgment and taste. However quiet it may be kept in tone and in good hands it is always quiet; however rich and varied in colour, it can always be seen, as it does not depend on the light for its due effect, either in the same degree or in the same manner in which carving depends on it. I am not making general comparison between the advantages severally of carving and marquetry for the purposes of decoration, nor do I wish it to be for a moment supposed that I think marquetry can ever supersede carving for general purposes, even if the thing were desirable.

This is merely a protest against the grievous waste of time and of skilful, and frequently artistic, labour caused by architects and designers through their inability to grasp beforehand the idea of the modifications which will be brought about in the effect of their work by the conditions under which it will be seen. The decoration on small pilasters and capitals as applied to furniture and carved in these woods, is rarely seen at all, except on a rough and disturbed surface. Still more rarely can enough of the motive or details be made out to awaken any interest in it.

Assuming that about the same quantity of detail is introduced—(which is usually the case) —the carving on a pilaster 3 ft. by 9 in. can be done as quickly, and at no more—probably less—cost than the same design 1 ft. 6 in. by 4½, namely, half the size. There is no question of delicacy or refinement in this relation.

The inferior carver will inevitably give you a coarse and clumsy rendering of the small design, if you trust him with it. From an artist you will just as surely get a suggestion of—refinement and delicacy pervading all the work in the large panel—though each man works from the same drawing or even the same model Moreover in the larger carving one is much more independent of the markings in the wood, by reason of the fact that the sinkings and shadows are deeper and stronger, and so in a measure, control the disturbing colour.

Apart from the question of cost which is always in favour of tarsia, there is this essential difference between the two methods, that while carving must always depend in a large measure on the direction of the light for its effect as carving (you can destroy the effect of carving which is in low relief at any time by a direct front light), the use of inlay makes the direction from which the light enters the room a matter of no moment—so long as the light reaches the object decorated.

I cannot close this paper without some reference to the practice so prevalent among writers on art, and especially applied art, of comparing the conditions under which the work was produced two or three hundred years past, with the conditions which obtain in our time. By no conceivable combination of circumstances can we ever get back to the conditions under which those workers produced their work, and although the productions of the writers above mentioned are frequently pleasant reading they

are rarely helpful, and indeed we—as artists or craftsmen—have but little concern with them, we must accept matters as we find them and do our best under the changed conditions. Moreover it is so easy to write in that way. The contrasts between the prevailing conditions and those of the past are so sharp—the change so complete—that a writer in this kind, possessed of only very ordinary ability, can hardly fail to be at least picturesque. We are so frequently told by poetical writers on art that a designer should, wherever practicable, carry out his design himself in the material for which it is intended. No artist who has a design in which a really fine idea is embodied need be told this; he would probably be but too glad of the opportunity to do this assuming that he had ever had the chance to obtain the requisite knowledge and skill in craftsmanship. His ideas are the children of his mind born not without travail—and, when it becomes necessary to hand them over to strangers for their material development, he does not part from them without a pang.

The modern designer, though he be really a master of his own branch of art in all its details, must needs leave a good many of those details to other and more mechanical hands.

[Mr. Webb sent some fine specimens of ivory inlay work for exhibition.]

DISCUSSION.

Mr. LEWIS DAY said they must all greatly regret Mr. Webb's absence, because it was always delightful to hear a workman talk about his work, still it was very interesting merely to hear read what he had written, and he could only say that he endorsed it cordially, and especially the concluding remarks about the absurdity of modern faddists who wanted them all to go back to the year 1. He thought those men did more harm to art than they knew, and it was good to hear a workman like Mr. Webb say what all workmen felt.

Mr. PHILIP H. NEWMAN said he felt in much the same position as Mr. Day, except that he did not come with any idea of questioning what the author said but to learn something about marquetry of which he knew nothing whatever. This paper had cleared up all his doubts and misgivings as to what marquetry ought to be. They must all regret Mr. Webb's absence and the cause of it.

Mr. PHENÉ SPIERS said he knew nothing of inlaying, and his recollections of what he had seen in Italy was rather faint, but he remembered looking at some of those marvellous examples referred to in the Italian choir stalls without any idea that they could be reproduced. The perspective of some of the interiors was marvellous, but he did not know that it could be recommended for imitation. The specimens exhibited were very beautiful, but he thought the effect produced was a little monotonous; there was too much detail. He had seen specimens of inlay in which the style was broader, the design being made up of larger masses. This was too much like lace work or a wall-paper pattern. He had seen some modern marquetry which was about the best class of work one could find anywhere, namely, the chapel which Burges decorated at Worcester College, Oxford. In that chapel you would find more modern ideas of decoration than anywhere else he knew of. The chapel was built at the end of the 17th century, and when Sir Gilbert Scott was asked what should be done with it, he said they had better pull it down and build a Gothic one; however, they did not like to do that, and eventually applied to William Burges, who advised them not to destroy it but to decorate it as it was, and the results were most wonderfully beautiful throughout the whole building. In the pavement in front of the altar and every other portion of the building he brought in perfect specimens of modern craftsmanship, and he could only recommend students and workmen to go and see it

Mr. W. AUMONIER said the paper was very interesting, but he could not help thinking that in the specimens of ivory inlay exhibited, Mr. Webb had gone a little in the direction which he had condemned, as there was too strong a contrast and a want of harmony of colour. There was a beautiful harmony in some of the Italian inlays, and he was at one with those who condemned perspective work in inlaying.

Mr. LEWIS DAY said he should like to say a word more in defence of Mr. Webb's work, because he did not think that he had been quite fairly judged by Mr. Spiers and Mr. Aumonier. There were two kinds of effect to be obtained in inlay. You could get colour which was very beautiful, but you might also go for line, and in the specimens exhibited Mr. Webb had gone more for line, and it was beside the question to complain that he had not got colour. It was not right to compare this work with that done for church decoration, which was necessarily on a much broader scale. No doubt if Mr. Webb had had an opportunity of decorating the choir of a church he would have done it much in the style Mr. Spiers suggested, but these specimens were done with a view to being placed in a modern drawing-room. They all knew what a modern drawing-room was. It would be a mistake to decorate a modern drawing-room with bold effective work out of scale with all the other contents of the room. Mr. Webb's inlay was beautiful work, admirably suited to its purpose.

Mr. C. BESSANT said he knew something about the practical details of inlay work, and had great sympathy with it, as much as with wood carving, although it stood on quite a different footing and was applicable to different purposes. Many surfaces had to be plain, and in such cases inlay work would come in, though it was now rather neglected. If Mr. Webb did not do such work as had been shown he did not know who could do it, and it had a value in that respect. He looked upon it more as a piece of jewellery, a thing to be taken up and examined closely. If you wanted to have a broad effect you would use larger masses and not introduce colour; but even style had its value, and anyone who knew the difficulty of producing that kind of work must admire it. Whenever he explained to anyone how marquetry work was done, they always went away with a far better appreciation of its value than they had before. It was an art much neglected by architeets, principally because they did not understand the materials used, and were rather afraid of it. Some of the best work was that treated in a very broad way with simple woods, such as box, in combination with dark woods. In the case of ivory, the inlay was cut out first before the ground work; in broader treatment you can put the two woods together and saw them through, and get all sorts of effects with the aid of shading by means of warm sand. In much of the old work the wood of the ground was cut right away, and as they had no glue to fasten the inlaid pieces they were fixed with small pins.

Mr. HAIGH said he had an old piece of work in which there was a good deal of green colour. He should like to know what wood that was.

Mr. BESSANT said it must be dyed; he could not say what dye was used.

Mr. A. PAYNE said they were much indebted to Mr. Webb for bringing forward this subject. In this country there was very little inlay work in the churches and cathedrals; but on the continent there was a great deal of it, especially in Italy. There was some charming work in the pulpit of a church at Sorrento and at Florence, the whole cathedral was one mass of inlay work. There was a good deal of inlay work in marble in some of the churches; for instance in the church of the Jesuits at Naples, where the columns, the walls, and the floor were inlaid; in fact it was rather overdone. Even with regard to wood inlay, there was comparatively little old work in this country; there was a little in Westminster Abbey, by Italian artists.

Mr. NEWMAN desired to add a word in defence of Mr. Webb. They came there to listen to his paper, not to criticize these particular works, which he took it were simply sent as specimens of the kind of work which was most difficult of accomplishment; the inlaying of wood with ivory.

The CHAIRMAN said he should like to add his testimony to the beauty embodied in the panels submitted by Mr. Webb, but it was clear that they were sent rather as *tours de force* than as examples of the author's mode of treatment for panels on a larger scale. He did not know any artist who had a more refined feeling for his work, and he was sure he would appreciate Mr. Aumonier's remarks as to the treatment of larger surfaces, and that he would give these a different treatment altogether. It always seemed to him that the Norfolk churches with their large panels of stone, filled in with cut flint, were the noblest examples of pietra dura work the world possessed. The Italians in their marble work had degenerated into little ornaments, birds, and fruit – mere playthings, but that flint work in Norfolk was on a nobler scale, and showed great breadth and contrast of form and proportion. Again, the Sviza room at South Kensington had some very interesting pieces of holly inlaid into panels of oak which was purely English, and provincial; they were somewhat rough, but exceedingly well done and in good scale. Another side of the subject which had not been touched was the great use of the art in South Germany and Switzerland, good effects being produced by the juxtaposition of various woods. It was inlaid, but inlaid solid, not veneer, but in some cases quite thick. A museum had been formed in Zurich within the last ten years, in which could be seen complete rooms, not only from Switzerland, but from Italy—one especially from Lugano, which was a beautiful example, in which the cornice and panels in the ceiling were inlaid. In Salzburg, Munich, and Berlin there were also beautiful specimens of South German inlaid woodwork. The architect who had designed the wall had given it rather too much projection in some members, and this had been redeemed by the treatment of the panels, and a charming effect had been produced by the inlaying of Hungarian ash with walnut and oak. At Ulm, again, he could recall a charming little house, now the museum of the town, in which the doors, architraves, cornices, and ceiling had this method of decoration carried almost to excess. In that museum, also, there was some of the most beautiful inlaying in colour on the backs of fiddles and other musical instruments, which were made in that district in the 17th and 18th centuries. The colours of some of those groups of conventionalised floral forms surpassed anything he had seen. This kind of work seemed to have been peculiar to southern Germany, especially Wirtemberg and Bavaria, and also the southern shore of Lake Constance. Inlaying was certainly worthy of more attention, and might be more used as a means of producing a good effect, where the architect and designer could meet on common ground without any rivalry. He concluded by moving a hearty vote of thanks to Mr. Webb, which was carried unanimously.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 19, 1899; W. Boyd Dawkins, F.R.S., in the chair.

The following candidate was proposed for election as a member of the Society:—

Lowe, C. W., Summerfield-house, Reddish, Stockport.

The following candidates were balloted for and duly elected members of the Society:—

Ash, Thomas Henry, Avonmore, Dudley-park-road, Acocks-green.
Barrett, C. Foster, Sheepcote-road, Harrow.
Batho, William John, Finchley and Hornsey-lane, N.
Benjamin, Henry Neville, 34, Devonshire-place, W., and 16, Leadenhall-street, E.C.
Bentley, Horatio Haliburton, 5, The Campsbourne, Hornsey, N.
Cochrane, J. R., J.P., Calder-glen, Blantyre, N.B.
Culbard, Arthur Dingwall Fordyce, A 24, Exchange, Liverpool.
Curwen, Charles, 39, Victoria-street, S.W.
Edwards, E. Montague, 162, Romford-road, Stratford, E.
Good, Montagu, Bonsor Gold Mining Company, Selukwe, Rhodesia.
Longmore, William Alexander, 13, Prospect-hill, Walthamstow, Essex.
Lyttelton-Annesley, Lieut.-General Arthur Lyttelton, Templemere, Weybridge, Surrey.
Mackenzie, Alexander Marshall, 1, Bon Accord-street, Aberdeen.
Merry, Alfred, 4, Orient-terrace, Manor-road, Liscard, Cheshire.
Meyer, Carl, 35, Hill-street, Mayfair, W.
Pollock, Mrs., 40, Thurloe-square, S.W.
Runge, Adolphus, 4, East India-avenue, E.C.
Williams, Charles Thomas, Madras, India.
Wyllie, Major John Alfred, Rangoon, Burma.

The paper read was—

OUR COAL SUPPLIES.

By T. Forster Brown.

The writer's apology for bringing this subject before the Society of Arts, is his desire to enlist the assistance of its members in inducing politicians and the public generally to consider and deal with the material and important problems which underlie the coal question, with the primary object of providing, if practicable, a remedy for, or counterpoise to the effect of, the future increasing cost of our supplies of fuel.

This future increased cost of coal, reacting upon the whole of our manufacturing industries, will undoubtedly land the nation in serious financial and political difficulties if remedial measures are not adopted, and these measures, to be of value, should be inaugurated during the period when the possession of good and cheap fuel enables the nation to maintain its commercial prosperity.

I will not attempt to dwell upon the origin and nature of coal, but proceed at once to the main problems I desire to direct attention to, and, shortly stated, they are:—

1. That whilst we have in Great Britain large unworked coal resources, sufficient probably to maintain a rate of working exceeding our present annual output for 300 years, or thereabouts, we are now rapidly exhausting the cream and cheapest of these resources; and in 50 years or thereabouts the greater part of the most valuable of our coal supplies will have been exhausted, except only such as can be worked at a greatly increased cost, which cost after half a century will rapidly increase.

2. That the United States of America possess far more extensive coal-fields than those of Great Britain, and that country already produces coal at a somewhat cheaper cost than we do, and so far as physical conditions affect the cost, will continue to produce cheaply for a far longer period than we can. With the exhaustion, therefore, of the cream of our coal-fields, and when we shall have nothing left but our more costly coal to work, the American competition will become of far more serious import to this country in all our commercial relations than it is likely to be in the immediate future.

3. The large coal-fields of Russia and China, when further developed, will also become serious additional factors in competition with us in the future.

Upon the first question of the coal supplies of Great Britain, I cannot do better than follow Professor Hull's (than whom I know no better authority) careful estimate of the approximate quantity of workable coal which will remain unworked at the end of the present century down to a depth of 4,000 feet below the surface, which is the probable utmost limit of depth at which it will be practicable to work coal. The resources exist in six large coal-fields, and a small quantity in Ireland, plus some small addition due to an extension of the coal measures between Dover and Bath.

These coal-fields and their estimated resources in seams of two feet and upwards in

thickness, down to a depth of 4,000 feet, as given by Professor Hull are as follows :—

(1.) The Midlands, extending into the counties of York, Derby, Nottingham, Stafford, Leicester, and Warwick. From this district, house, manufacturing, and steam coals are chiefly produced. Estimated resources, 35,000,000,000 tons.

(2.) The Great Northern, extending over portions of the counties of Northumberland, Durham, and Cumberland, chiefly the two first named counties. House and gas coals of the best quality, and steam and manufacturing coals are produced. Estimated resources 6,000,000,000 tons.

(3.) The North-Western, comprising Lancashire, East Cheshire, &c. House, gas and manufacturing coals. Estimated resources 11,000,000,000 tons.

(4.) Western group, comprising Bristol, Somerset, and Forest of Dean. House and second class steam coals. Estimated resources 2,000,000,000 tons.

(5.) The Welsh, comprising South Wales, including Monmouthshire, Denbigh and Flint. Steam, house, gas and manufacturing coals. Estimated resources 20,000,000,000 tons.

(6.) The Scotch, comprising the series of coal basins which extend across Scotland from Ardrossan to the Firth of Forth. Gas, steam, manufacturing, smelting and smith's coals. Estimated resources 8,000,000,000 tons.

(7.) The Irish coal-fields are estimated to contain of visible and concealed coal to the extent of some 155,000,000 tons. Making the total available coal resources in the year 1900 about 82,000,000,000 tons.

The conditions which regulate the value of the coal resources of all coal-fields are many and various : the thickness of the seams, their depth below the surface, the friability or otherwise of the roofs and floors of the seams, the inclination of the seams of coal, the dry or watery nature of the strata associated with the coal-beds ; and the coal itself, its friability, the proportion it contains of carbon and hydrogen, and other volatile matter, and its comparative freedom from indestructible ash and sulphur.

It follows that whilst one coal-field, or part of a coal-field, may be extremely valuable owing to the measures lying nearly horizontal and at no great depth below the surface, the great thickness of certain seams, their high quality, and the general favourable conditions for working and so forth, another coal-field, or another portion of the same coal-field, may be of little value owing to the seams existing at great depths, involving heavy pumping, being thin, lying at steep gradients, containing too much or too little volatile matter, or too much dirt and refuse in the form of ash and sulphur, making it impossible to work such inferior seams of coal in competition with the best coals.

More clearly defined, the most valuable part of any existing coal-field, in this or other countries, comprises seams of upwards of three feet in thickness of coal, containing from 12 to 30 per cent. of volatile matter, and in the case of certain anthracite down to 6 per cent., and leaving a residuum after burning of from 2 to 5 per cent. of ash, and from ·50 to 1 per cent. of sulphur, which seams are deposited upon an easy inclination and with good roofs and floors. Whilst the less valuable seams of coal-fields contain coal-seams from two feet and upwards in thickness, containing from 5 to 12 per cent. of volatile matter, and again from 30 to 40 per cent. of volatile matter, also thick seams of best quality existing at great depths, steep inclinations, and so on, so that practically whilst certain coal-fields of the world produce coal of exceptional quality, such as the steam coal of South Wales, the gas and bituminous coals of Durham and the Midlands, the furnace coal of Scotland, the cannel coal of Lancashire, the anthracite and semi-anthracite coals of Pennsylvania and the Pittsburg region of the United States, and the coal of the Westport coal-field of New Zealand, which last named is a deposit of Cretaceo-Tertiary age, nearly every coal-field contains a considerable proportion of comparatively inferior deposits, and many coal-fields, more particularly those which are of a more modern geological age than the Carboniferous period, do not contain any of the most valuable coal deposits. Therefore, in taking the measure of the extent and resources of our coal supplies, it becomes of importance that we should have all the circumstances in our minds before attempting to generalise as to the real value and extent of our coal resources, what proportions are good and cheaply worked, and what proportions are of less value, and, under existing conditions not capable of maintaining such a supply of cheap and high-class fuel as will enable our industries and manufactures to compete successfully with the products of countries which possess better fuels which are worked at a cheaper cost.

Taking all the circumstances into consideration, the author of this paper estimates that of the best and cheapest of the coal supplies of

Great Britain there originally existed about 20,000,000,000 tons, existing at a less depth than 2,000 feet below the surface, and that there may be probably still remaining at the end of 1899 about 15,000,000,000 tons of this quantity, the bulk of which he estimates will be exhausted by the middle of the next century, leaving about 67,000,000,000 tons of coal still available, sufficient to supply 250,000,000 tons a year output for upwards of 250 years, but comprising coal either of inferior quality or best coal obtainable at a greater cost per ton than at present prevails owing to physical disadvantages by reason of depth and so forth.

The present depths at which our coal mining operations are carried on are comparatively shallow. There are some few collieries working at depths between 2,000 to 2,500 feet, but the average depth below the surface from which our existing coal supplies are obtained will not exceed probably from 750 to 850 feet; this average depth will increase gradually, and it is apparent that when the average depth exceeds 1,000 feet, and still more when the average exceeds 2,000 feet and so on, the causes which enhance the cost of working due to extra depth will come more and more into operation.

Up to the present, the altered conditions due to higher temperatures, and increased cost of working due to depth and temperature, have naturally not made themselves apparent. Four thousand feet has generally been considered the ultimate limit in depth for all coal-working. It is doubtful even if this limit can be attained, but if it is, it will only be at a very high cost of working, probably more than double the cost of working which now prevails, owing to the reduction in the useful effect of labour in high temperatures, and the large consumption of power in raising from great depths.

Probably it will take 50 years before the general average depth of working the annual coal supply of this country exceeds 1,500 feet, but it follows that as the average exceeds 1,500 feet, a constant but steady increase in cost of working must set in.

The cost of working coal in this country has for many years past been an increasing one, irrespective of physical causes, and at the present time there is no indication that this gradual increase of cost will not continue to operate. The causes are chiefly the increased cost of labour, the extra and increasing burden of rates and taxes, and the larger colliery staffs and improvements necessary to meet the various requirements of the Coal Mines Regulations and Workmen's Compensation Acts.

But so far as cost is affected by natural causes, depth, thickness of seam, and quality, I think it will be a reasonable supposition that a moderate cost will prevail for another fifty years, at the end of which period physical causes will begin to operate which will have the effect of steadily increasing the cost until it reaches such a figure as to render profitable mining operations impossible, and this limit is believed to be about 4,000 feet below the surface.

It may be argued that with our increasing cost, means will be provided to reduce that cost with improved mechanical appliances and so forth. This alternative, however, will not bear investigation, for, as time goes on, although undoubtedly improvements will take place in mechanical appliances, in the application of labour for "getting" thin seams, in hauling, and in the manipulation of the coal when it arrives at the surface, but these improvements will equally apply to the operations of our competitors in other countries, and will still leave unsolved the comparative increase of cost due to great depth and high temperature, and increased cost in the working of thin seams in competition with the working of thick seams, and to a certain proportion of coal having to be worked of inferior quality and of less evaporative power.

At present, the greater part of our coal output is being worked from collieries possessing the thicker and more valuable seams lying at comparatively shallow depths below the surface; and we shall certainly, within the next 50 years, see an appreciable diminution of output owing to approaching exhaustion of these collieries, and there remains, at present, comparatively few unlet mineral tracts in this country, except where the coal lies at a great depth.

Of course, the duration of what at present remains of the cheaper and best coal seams depends upon the rate of output, but the period of exhaustion must sooner or later arise.

Summarising our coal resources, we have—in seams of 2 feet and upwards in thickness, within a depth of 4,000 feet below the surface—an estimated available quantity of coal (visible and concealed), including the Irish coal-fields, of 82,000,000,000 tons.

Now it may be well to inquire how far is this total of 82,000,000,000 tons, which is sufficient, at our existing rate of output, to supply the

requirements of Great Britain for at least 300 years, available at a reasonable cost?

To begin with, from the commencement of the present century, and previously, coal has been worked, and at an increasingly rapid rate during the last 25 years, from the thickest seams of the best quality existing near the outcrop and down to a moderate depth below the surface, and the quantity already worked exceeds 5,000,000,000 tons. The good coal near the outcrops has been already practically exhausted and deep pits in later years have been necessary to win some of the best seams.

Anyone who is practically acquainted with coal mining is aware that with this increasing depth there is a distinct increase in the cost of working, and if all our coal at the present day was produced from a depth of 2,000 feet it would be much more costly than is our average present cost of working.

Once a depth of 2,000 feet or thereabouts is reached the effects of the increase in temperature and pressure due to depth begin to operate, in addition to the cost of the increased power required, and of course increased depth means greater capital outlay, and the interest upon this increase of capital also becomes a fresh charge upon the mineral produced.

Fifty years ago the average depth from which our coal supply was obtained was probably less than 300 feet below the surface. To-day the average depth from which the whole of our annual supply is obtained may be taken to be about 800 feet, and 50 years hence the average may have increased probably to 1,500 or 1,800 feet, the larger annual output rendering the process of exhaustion, as regards depth, more rapid in the future than it has been in the past.

The increasing cost due to the greater depths of winnings, so far as it is merely a question of more expenditure of power, has been and will be met partly by improved mechanical appliances as previously mentioned, increased outputs and so forth, but when the temperature becomes so high as to reduce the useful results of manual labour and horse-power, then we have a new element introduced which inevitably increases the cost.

The writer's experience in colliery operations, carried on at depths exceeding 2,000 feet, fully bears this out, and although it may be practicable to modify the conditions, even in regard to temperature, in some degree, a serious gradual increase of cost due to increased depth, &c., is inevitable. And already, notwithstanding the various improvements which have been effected in mining operations during the last half a century, the average cost of raising coal to-day, irrespective of fluctuations in wages, is probably 15 per cent. above what it was 50 years ago.

The fact that within the last 25 years a great number of collieries have been opened upon large areas of coal-field, and that it will require 30 to 60 years to exhaust the resources of these modern collieries, indicate approximately the period when the cost will rapidly advance. It will only be upon the exhaustion of the bulk of the best coal available to already existing collieries, and the future output having to be maintained by recourse to deeper winnings that an important step in the direction of increased cost due to depth will begin to operate. Therefore, whatever remedial measures are adopted, they ought to be so arranged as to come into partial operation by the end of half a century, and be capable of adjustment so far as they can be utilised from decade to decade to counteract the effect of the increasing cost of working these remaining portions of our coal supplies.

It may be of interest here to state that a reasonable estimate of the horse-power produced by such portion of our annual output of coal as is utilised for industrial purposes is about 25,000,000 horses, and the approximate present cost at the points of consumption at between 25s. and 35s. per horse-power per annum; whilst if all our exports of coal and coal used for gas, and household purposes were included, it would represent 50,000,000 horse-power per annum, if it were practicable for man to perform the same labour, but it is not to the work of a population of 500,000,000 working people who would have to be supported.

I may refer, before approaching the question of the American coal-fields, to Mulhall's estimated areas of coal lands in various countries, which he gives as follows:—

	Sq. miles.
Great Britain	9,000
United States of America	194,000
Russia	27,000
China and Japan	200,000
Germany	3,600
Belgium and Spain	1,400
India	35,000
France	1,800

To which might be added enormous areas of lignite in various parts of the world. The coal-fields which have just been enumerated are chiefly of the Carboniferous period.

Our colonies of North America, Australia, New Zealand, and South Africa, are not given.

Assuming the coal acreage of America, China, and Russia, to contain a fair proportion of workable coal, it will be apparent how far in excess of our resources are those of these three countries, and that consequently how much larger is the extent of coal accessible in these countries, either without pumping, or at very shallow depth below the surface, and therefore at a cheap cost, compared with Great Britain.

2. With regard to the second head, that the United States possess more extensive coal-fields than Great Britain, and that their competition in the future will become serious in our foreign markets, including the markets of the United States.

America produces coal of all qualities, and the coal-fields extend over an enormous district of country provided with excellent railway accommodation; the rivers also afford unusual facilities for the internal cheap conveyance of the minerals. The great drawback of the American coal-fields, and our chief safeguard in regard to their competition with us in foreign markets, is the great distance at which the important American coal-fields lie from the Atlantic sea-board.

Nevertheless, America has made rapid strides in the direction of competition with this country —(1) By the cheap construction of the railways, and (2) by the exceptionally low rates per ton per mile charged for the carriage of minerals. These rates are something like one-fourth of the current rate per ton per mile charged for similar traffic in this country. At present, coal from the neighbourhood of Pittsburgh is delivered on the Atlantic sea-board at a lower rate per ton than coal of a similar quality is sold F.O.B. in this country, yet the distance from Pittsburgh to the sea-board is about 300 miles, I believe, and the cost of carriage of coal, I am advised, does not exceed one dollar per ton.

The American anthracite coal of great purity is widely and successfully used for commercial purposes, and the carbonaceous steam coals are of a high class quality, but so far as the writer is informed, are not so hard and do not bear carriage so well as the best Welsh steam coal. Notwithstanding, however, our low cost of working and cheap sea transit of late years, we are beginning to feel the pressure in our distant markets of the American competition. This competition will not become less severe probably in the immediate future, but if the time arrives that British coal becomes more permanently costly F.O.B., the American competition will assume serious proportions.

3. Upon the third point of the competition of the Russian and Chinese coal-fields.

Russia possesses coal-fields of at least three times the area of those of Great Britain, and is now beginning to develop her coal resources in the South near the Black Sea. The present supplies are applied chiefly to home consumption for household and manufacturing purposes. The Russian coal is of various qualities, and ranges from anthracite to highly bituminous. It is produced at the present day in some districts in the writer's knowledge at a lower cost per ton than is the average cost of working in this country.

The distance of the Russian coal-fields from her sea-boards is greater than in Great Britain, and we have thus, as in the case of America, more or less of a safeguard, so far as competition with us in foreign markets is concerned, but the much greater coal-fields of China are now on the point of being more or less extensively developed. The extent is variously estimated, but it is probable that the Chinese coal-fields extend over a surface area equal in area to the American coal-fields and there are reasons for believing that in the neighbourhood of the Gulf of Pe-chi-li collieries will come into working operations within a short period. This part of the Chinese field is believed to contain coals of good quality for navigation and manufacturing purposes, and is comparatively near the sea-board. The large coal-fields of Central China may not be developed so rapidly, but it may be noted that although distant from the sea board, yet the facilities for transit afforded by the large navigable rivers and cheap labour reduce the effect of this distance immensely and the carriage from these inland coal-fields will probably represent a moderate cost. Besides for internal consumption, provided the coal is good and worked cheaply, the distance to the sea-board is not so important.

The cheap labour available in China, and the shallow depths from which their coal will be worked, indicate that the Chinese coal will be delivered at the sea-board at such a low cost as will enable that country to compete with all other countries for the trade of the Eastern hemisphere. We have therefore, undoubtedly to anticipate very keen competition in the future, so far as our markets in that region are concerned, for many descriptions of manufactured goods and for coaling

the mercantile marine which frequent the Eastern seas.

The conditions prevailing in these principal foreign coal-fields are, therefore, in the direction of cheapening the production of coal; whilst in this country the tendency of the conditions is to increase the cost of working coal, and unless we can ultimately do something material to check this increase of cost, a time will arrive—the author thinks in half a-century at the latest—when as a nation we shall have to face the probability of our manufacturing position being rapidly effaced in consequence of the dearness in cost of the fuel we have to employ in our various manufacturing processes, and in the supplying of our mercantile marine as compared with the cheapness of the coal used by our competitors.

Then, with regard to Germany and Belgium. These two countries are our chief manufacturing competitors in Europe. The German coal-fields are less in extent than our own, and the average qualities of their coals is possibly somewhat inferior compared with the best of our coals, yet Germany, by reducing the cost of carriage on her State railways to less than half the rate per ton per mile charged in this country, has been able to develop a large and increasing home and foreign coal trade from her principal coal-fields in Westphalia. As time goes on, however, difficulties will arise in Germany as well as in Belgium from increasing depths, and they will be of the same character as those we shall have to contend with in Great Britain. Germany and Belgium will, however, be probably in a worse position than we are, because they have already reduced their rates of carriage to a minimum, or thereabouts.

To Germany and Belgium the industrial competition of America and China will therefore be of the most serious import. Germany, however, is not as dependent on her coal for her maintenance and prosperity as we are on ours. The area of Germany is large, and her soil is more productive, and will feed a much larger population than the soil of Great Britain can support. Reviewing the whole question, this country is exceedingly well placed with regard to the distribution of her coal-fields, situated as they are generally near the sea-board, and possess coals of exceptional quality; so long, therefore, as our high-class fuels are producible at a moderate cost, we shall, provided we retain our maritime supremacy, in all probability remain in a flourishing commercial position, so far, at any rate, as physical conditions affect the question of the cost of producing coal. In regard, however, to our internal means of communication, although a very comprehensive system of railways has been established for the accommodation of the enormous traffic of this country, the rates charged for transit as compared with those current in America, Germany and Belgium, especially for minerals, are exceptionally high, about four times the American rate per ton per mile, and twice the rates charged by Germany and Belgium. But notwithstanding this fact, by reason of our nearness to our home markets and to the sea-board, so long as our best coal remains unexhausted, at a moderate depth and cost, we shall probably be able to hold our position in the markets of the world with our manufactures.

But as the writer has suggested, in half a century from the present time conditions will become unfavourabe for the production of cheap coal, and the problem he wishes to discuss is the nature of the remedial measures, if any, which it may be practicable to adopt to enable that half-century of probable prosperity being extended to two to three centuries.

If from the national point of view it was considered essential that the nation should possess all the turnpike roads in the country, how much more is it necessary that the nation should possess the railways, which are the far more important means of internal communication? Unfortunately, no provision was made for the State-building of the railways, although power was obtained in 1844 by means of which they can be purchased by the State, I believe, at any time. The railways have been constructed by private enterprise at an enormous cost, due to various causes; the annual net revenue, however, under existing conditions is something like £40,000,000 per annum, and in 30 to 40 years the net income will probably have increased to at least £50,000,000 per annum.

To this should be added the enormous loss by reason of the present system of management, the unsuitability of the rolling stock for economical working, and unnecessary competition involving the running of trains with inadequate loads, &c. Probably, the income of the railways of Great Britain, if they were in one hand, and the management organised on different lines, would represent an annual net revenue in 30 to 40 years time of £60,000,000.

Now, if this fund of £60,000,000 per annum or such part of it as becomes necessary were available to be drawn upon; that is to say, if

the railway rates for all classes of minerals, goods and passengers were reduced decade by decade to counteract the general effects of the increased cost of producing the minerals, we should be able to utilise the whole of our existing coal resources under practically as favourable conditions as we shall utilise the best and cheapest of our coal resources during the next fifty years.

Future of Coal.

It may be contended that at some period in the future a successful substitute for coal may be discovered, but we must bear in mind the extreme cheapness of coal and the possibility of so economising its consumption, that 2½ lbs. of coal per hour will produce one horse-power on the average, equal if coal is valued at 7s. per ton to one horse-power fo 10 hours per day for 1d. It does not, therefore, appear probable that a substitute of equal power is likely to be discovered at anything approaching such a cost, and what will happen as coal becomes dearer in this country, will be a gradual transference of the manufacturing operations which supply the world to countries where the cheapest coal is produced.

It further follows that so long as cheap coal can be worked in this country, the demand for it will continue to increase until at all events all the moderately deep coal areas available in Great Britain are occupied, and it may, it is suggested, be assumed that before the whole of those areas are occupied the output of coal, now slightly over 200,000,000 tons per anuum, will be increased to 250,000,000 tons per annum.

And now as to the vexed question of our expensive means of internal communication in this country. It would appear that if during the next half-century the nation is spared international difficulties, such as a great war, we may expect to enjoy a most prosperous period in our manufacturing industries owing to the large supply of cheap and good coal. With markets in our widely-spread colonial empire, our position will remain unique, and if during that period something can be done to counteract fully, or even partially, the increasing cost of producing coal which will inevitably subsequently arrive, then the nation will be in a condition to maintain its existing commercial prosperity, so far as cheap coal is concerned, for centuries. But having regard to the long period during which this prosperity may be expected to prevail, and the economical conditions under which the nation may exist, other favourable conditions may be created such as that of becoming the home of the finer industries, involving the employment of much labour and less fuel. This country may also become populous as a residential country, and, as it is the centre of a great empire, cheap coal supplies may in the far distant future become less of an urgent necessity.

The direction in which relief is to be found is the cheapening of our internal communications, and the reduction of our rates and taxes. Now the only mode of doing this appears to the author to be the repayment during the next half-century or thereabouts of the whole of the capital outlay of this country in railways, docks, sanitation, water, and other public workings.

It is obvious that the nation, in paying off the National Debt at a substantial rate, is providing in some degree for the relief of future generations, but whilst the repayment of this debt is of undoubted importance from the point of view of relief to our successors, and in providing a fund from which we can obtain loans for carrying on warfare, it may be observed that the permanent relief to the nation by paying off the whole of this debt will be about £25,000,000 per annum, an annual amount which has been swallowed up during the last few years in increased annual national expenditure. Assuming that by means of the repayment of the National Debt the annual expenditure to maintain our Army, Navy, and Civil Services, and Education, is reduced to under £100,000,000, how can even this enormous revenue be obtained if our commercial supremacy were to disappear, owing to our country possessing cheap fuel?

Would it not be more prudent and far-seeing to apply the funds now devoted to repaying the capital of the National Debt to the acquisition for the State of our railways &c. From the revenue obtained, complete the repayment of the National Debt capital, during the considerable period, probably of a century after obtaining possession, when it would only be necessary to reduce the charges on our railways by a certain proportion only, still leaving a large revenue from the railways, plus the economies which would be secured in working them as one undertaking.

In this way the continued prosperity of the nation would be secured, as well as a fund be created, available for repayment of what may then remain of the National Debt capital.

Upon the assumption that the capital outlay upon railways and docks, and the local charge

for interest on loans for sanitation, water, &c., had ceased, rates and taxes would be reduced to a minimum, and ultimately, as the necessities of the commerce of the country required, the cost of travelling and the rates chargeable for goods, minerals, and live stock could be gradually from time to time lowered, until these charges are reduced to the bare working expenses.

This operation, if carried out, would have the effect of materially reducing the cost of living, food, and clothing, rent would be less costly, and labour would probably become much cheaper.

The whole of the indebtedness of this country for railways, docks, drainage, and water, and lighting may be estimated approximately at 1,500 millions of money (of these the first four mentioned are in private hands, the others are owned mainly by public bodies); if the interest upon this money were to cease, it would relieve the nation by at least £60,000,000 per annum, and this upon 250,000,000 tons of coal represents an amount which would more than counteract any increase in the cost of coal due to natural causes alone, until the practical exhaustion of our coal supplies.

If, however, this enormous capital is allowed to remain until the prosperous period of low cost of coal passes by, it would not be practicable to reimburse this capital, and the amount remaining unliquidated would become lost, and so cause widespread ruin to individual shareholders as well as to the nation.

What is suggested, therefore, as regards the railways is:—

1. That either the reversion of the railways should be purchased by the Government, taking effect at the end of say 50 years, and that afterwards the railways be worked under Government control, with such reductions in rates as the conditions of trade require, or

2. That the railway companies should be compelled by legislation to provide a sinking fund annually sufficient, at compound interest, to replace the whole of the capital which they have already created, or may create before the end of a period which the Legislature may fix after full inquiry. Part of the investigation would involve an inquiry as to how the amount of the sinking fund is to be obtained.

In the second event, at the end of the period, either the working of the railways should be taken over by Government or continued in private hands, subject to Governmental regulation, and absolute power to the State of reducing rates from time to time, and the surplus revenue, if any, during the earlier period when the increased cost of coal would not be so heavy, beyond the working cost, could be apportioned between the railway companies and the Imperial Revenue as might be decided.

A similar proposal might apply to docks, and modified conditions to the trading investments of municipalities. The compulsory repayment within a given period of the capital invested in lighting, water and drainage, would afford facilities for reduction in rates and taxes in those municipalities in which the capital had been repaid.

Now, the fact is undoubted that the cost of working coal will gradually increase owing to natural causes alone, and that the increase will begin to affect the industrial power of the nation seriously in half a century or thereabouts.

It is also a fact that there will still exist at that time large coal resources equal to more than a couple of centuries on a consumption of 250,000,000 tons per annum, or 25 per cent. more than the present annual output.

Are we to lose by neglect the profitable use of this enormous annual wealth, or shall we in time take such measures as will enable us to continue to utilise it? That the emergency will arrive cannot be gainsaid; the remedy, if a remedy can be found, is open to argument and inquiry: but the present is the time to make the investigation, and not when the actual contingency is at our doors. It is no answer to urge that our successors can take care of themselves. They will not have created the capital or had the benefit of the use of the capital, but if left to them unliquidated, it will weigh as a millstone around their necks.

Finally, I may glance at the objections which have been raised to the adoption of the suggestion advocated by the writer, viz., of paying off the nation's indebtedness in railways, docks, waterworks and gasworks, sanitary and other capital outlays, during the period when the production of the cheapest and best of our coal resources secure to the nation a commercial prosperity which cannot be hoped for after the exhaustion of the best of our coal resources.

The chief of these objections are:—(1) That science, before the expiration of 50 years may discover some efficient substitute for coal; (2) that the State purchase of the railways will place too much patronage and power under Government control; (3) that the railways will not be efficiently managed under State control; and (4) that the altered conditions

under which the nations compete commercially 50 years hence may be so changed as to render the possession of coal-fields not necessarily of paramount value.

Objections 1 and 4 may be considered together. To refuse to face the position in the hope that something may happen within the 50 years is tantamount to hiding our heads in the sand, and waiting for something to turn up. If some discovery of science provided an effectual substitute for coal, however improbable, we should not in Great Britain have a monoply of such substitute, but should have all the civilised nations competing with us. How infinitely stronger our national position for such competition would be if transport and inland communication by reason of the repayment of the capital value of our railways have been effected, was reduced by one half of what it is to-day, and our rates and taxes, by reason of the repayment of our municipal loans reduced to a minimum.

It would appear to the writer essential, whether we look at the question from the point of view of extending the period of the profitable working of our remaining coal resources, or from the point of view that at a certain period an efficient substitute for coal will be found, that the clearing off of the national liabilities, in means of communication, during the nation's prosperous period, would not only be the soundest of policies, but the only reasonable and prudent course to adopt. A prudent individual providing for his successors would undoubtedly adopt such a line of conduct, and if to an individual it is desirable, surely it is of paramount importance to a great nation to follow a prudent policy.

Then as to objection No. 2, that the State purchase of railways will place too much patronage and power in the hands of Government. I am aware and appreciate the serious objections to the course suggested from a political point of view; but the question whether we as a nation are to collapse financially in half a century, or continue to maintain our position for centuries, is altogether too serious to become the catspaw of any political party. If, however, the result sought of enabling the nation to reduce the cost of travelling and transit of goods and minerals by one half, when required after half a century, and a reduction in rates and taxes, can be equally well secured without the State purchase of the railways, then I should be content. The wit of our politicians surely can find some solution outside party politics of preventing the control of so many voters being used for party or Government purposes.

Possibly one way out of the difficulty is that suggested, by comeplling the railway companies to fund a portion of their income to repay their capital in from fifty to seventy years, the State being able to control absolutely permanent reductions of rates of carriage from the end of fifty years. This reduction would, as previously explained, be necessarily gradual, and only reach the minimum of the bare cost of working and management at a period considerably later than fifty years. If the course last-named were adopted, it would meet the third objection previously mentioned—that the railways will not be efficiently managed under State control.

I have now placed before you the problem of our coal supplies. The total supplies at the present and prospective rate of out-put will last probably three centuries, but the cheapest will only last half a century. That if we do not during that period of 50 years provide in some way to meet the gradually but steadily increasing cost of our coal, after 50 years, owing to natural causes, we shall be unable to compete successfully with America and the East, and it must follow that our commercial supremacy will disappear, whilst, it is suggested, if the capital value of our railways and other works were paid off in the 50 years and the cost of travelling and transit o minerals reduced by one-half, the increased cost of our coal, due to natural causes, would be practically neutralised, and the nation would be able to hold its own so long at al events as the coal resources of the country endured.

Is this not a question worth the serious present consideration of politicians and the nation although the actual emergency may be approximately half a century hence?

If the remedial measures suggested are inapplicable, or if other measures are preferable we ought to tackle them. The subject is wort investigation even if no practical remedy ca be found; it would be only prudent to face th difficulty, with a full knowledge of what w may expect as the future prospects of o country.

DISCUSSION.

The CHAIRMAN said there was no doubt that t amount of coal in this country was limited and w ascertained, and it was equally well known that th

were other areas outside of England where there were large stores of coal, partly in America and in China, and he might add to those, another country which had not been alluded to, Australia. He could not say exactly how many square miles of coal there were there but he knew from his own observation that there were not less than 39,000 square miles of productive coal measures, containing seams more than 2 feet thick in New South Wales, and extending indefinitely northwards far into Queensland, and westward past the Blue Mountains region, into the centre of Australia. He did not accept the definition of an Englishman as being confined to dwellers in the small island which was called England; we were inheritors not merely of old England or of new England, but of that greater England, of which Australia formed so important a part. It was a remarkable thing that the English race had managed to get hold of the greater part of the more productive coal areas of the world. First of all taking America, not merely in the United States, but in the far west of the Canadian dominion, on the eastern side of the Rocky Mountains, there was a vast tract of available coal measures verging on the margin of these mountains into the most valuable anthracite seams which would be a great source of wealth in the future. And right away to the north, almost as far as the Arctic Sea, following the Mackenzie River, there was evidence of this great coal-field, which was part of the heritage of the English race. He might also mention Borneo and the great coal-field in South Africa as yet undefined. While therefore he felt that the time must come when the supremacy of this small island must yield to some other community in some other region, he felt that in all probability that community would still be English. It would belong to the English race. England was called England because the English came over, found it an admirable place to live in, conquered it, and took it. What our ancestors did in coming to this country, we their descendants were doing at the present time in other countries: they were planting a greater England almost all over the world. He did not, therefore, fear in the least that the power of the English race would diminish. He looked forward to its commercial supremacy as being assured, though he admitted that England could not continue to be the great centre of the production of coal for more than 50 or it might be 200 years hence. Still, we need not lose our commercial supremacy. If we did not get our coal in Great Britain, we could get it in various parts of the world. He had not made any allusion to China, but he could not help thinking that when this scramble for China was over, it would be found that the stupid Briton (as he was sometimes called) had got hold of the corner lots, just as he had done over and over again before. With regard to the proposed remedies, he should be much interested in hearing the discussion; but it seemed to him that the remedy of cheapening transport was a very difficult one to apply. He did not think it would be possible to induce politicians to undertake the enormous responsibility of buying up the railways and all the municipal enterprises; and, on the other hand, he did not think the railways, except under compulsion, would reduce their rates. It would be impossible to do so under present circumstances, except at the cost of the shareholders, and therefore he saw enormous practical difficulties in that direction. Nevertheless, they owed their thanks to Mr. Brown for the admirable manner in which he had put this subject before them. Besides the question of the duration of the coal, there was the question whether there was any possibility of any other power, such as electricity, derived from water or some other source, to some extent replacing coal. The figure, based on the statement that a horse-power cost 1d. per day of ten hours, worked out to £3 13s. per annum; and it was a curious fact that the cost of an electrical horse-power ranged between £3 and £5. If you added the cost of the machinery by which the coal was converted into power, that would add considerably to the £3 13s., so that it would come to a figure probably greater than that of electrical horse-power generated by water.

Professor HULL, F.R.S., said there could be no question about the rapid exhaustion of the coal-fields. It was 1860 or thereabouts when he first undertook to make a calculation of the quantity of coal then existing in our coal-fields to a depth of 4,000 feet. At that time the output only amounted to about 60,000,000 or 65,000,000 tons per annum, and on that basis he came to the conclusion that our coal would last for 1,000 years. That was very satisfactory, and he and the rest of the community went comfortably to sleep about it, thinking there was plenty of time to deal with the matter later on. As time rolled on, however, the output of the collieries had rapidly increased, and now, as Mr. Forster Brown had said, our children or grandchildren might be brought face to face with a very important crisis in their commercial and manufacturing history—not the exhaustion of the coal, but the increase of its cost to such an extent that they would be handicapped with regard to manufactures compared with other countries. He did not see any possible escape from that position. In a longer or shorter period the cost of coal would be increased to such an extent that our mills and factories could not possibly be worked with the same economy as at present. There were only two ways in which the difficulty could be met. Either there must be a general decrease in wages, which no one would say was either desirable or practicable, or else manufactures must be reduced, and other countries would be able to compete in the production of cottons and other commodities, in which we at present held such an important position. He agreed with the Chairman in the wide view he took of this subject, that the centre of gravity of future manufactures and commerce must move either towards the west or

towards the south and east to Australia, or perhaps China. There were in China coal-fields of prodigious extent, as had been first shown by Baron von Richthofen and established by more recent surveys. If in the partition of China we got the lion's share and kept a sharp look out for those districts bordering the valleys of the great rivers where the coal-fields existed—recollecting that there were millions of inhabitants who would work for 3d. or 6d. a day, and do as much work as one got for 5s. or 6s. in this country—we might have manufactories established in China under British control which would vie with any in the world. It was said by some very sanguine people that when the coal became exhausted, or too expensive, some other motive power would be found; but they had been looking for it for a long time in vain. Some looked to electricity, but all the electricity generated at present in places like London or Manchester had to be provided by motive power derived from coal. Of course there was petroleum, but all the petroleum introduced into this country would be a mere fleabite compared with the coal supply. We had no Niagara in this country; if we had one in the North of England, we might set up a gigantic electric-power station, and supply all the factories in the centre of England; but there was nothing of the kind, and we could not even utilise the water supply from the hills without taking it away from the large towns which were already competing for it. But even if we lost a great deal of our manufactures, it did not follow that we should not remain the centre of commerce. Holland was a little kingdom which did not possess one ton of coal of its own, and yet not very long ago it was the greatest centre of commerce in the world.

Mr. ALEXANDER SIEMENS said the arguments brought forward in the paper were all based on the assumption that the manufactures of Great Britain depended in the main on cheap coal. At last year's meeting of the British Association, he read a paper on the cheap distribution of power, and put forward some figures which he could not now remember exactly; but he showed that in their works at Woolwich one quarter of the cost of power was due to coal, one quarter to labour, and one-half to fixed charges, interest, and depreciation. From that it could be seen at once that the cost of fuel was not so all-important as had been supposed. Of course, cheap fuel was an important factor, but it had not the overwhelming importance which Mr. Forster Brown sought to make out. He also referred to other countries, which he said had large coal-fields and cheap labour, and were therefore bound in future to cut out Great Britain altogether. They might do that if everything remained the same as at present, but it would not. When the coal-pits of Great Britain had to be sunk deeper, a great many more mechanical appliances would be used, and in spite of what Mr. Forster Brown, said he had full confidence that by using mechanical means the cost o coal would not be increased to such a degree as he feared. At present in foreign countries, coal-cutting machinery was very much more employed than it was in Great Britain. One great factor in the cheapening of coal was already applied to foreign countries, and still Great Britain was able to undersell them, though using the primitive means of hand labour; and therefore British coal owners would wake up to the fac that by applying machinery, they could cheapen coa instead of increasing its cost, even if they had to fetcl it from a greater depth. It was true also that i China at present people were content to work for 3d or 6d. a day, but when they came more in contac with civilisation their wants would increase; that wa the effect, and a very good effect too, of civilisation and they would not then work for 3d. or 6d. a day Great Brstain's coal-fields of 9,000 square miles had t serve for 40,000,000 people, the Chinese coal-field were four times as large, but they had to provide fo 400,000,000 people, or more; and when all thes people woke up and wanted a good deal more tha 6d. a day, they would want all their coal at home He anticipated that the price of coal would go u everywhere, so that the advantages and disadvantage of the various nations would remain very much in th same proportion as at the present time, and he di not believe that in fifty years Great Britain woul all of a sudden find herself incapable of manufacturing The more civilisation spread, and the more communi cation was increased, the more equal all nation became, and their relative importance depended on th natural resources at their disposal. As Mr. Brow himself said, England, as regards coal, was place extremely well; and, as Professor Hull remarked, was the same with regard to commerce. On th whole, therefore, he could not accept the gloom picture which had been drawn of Great Britain fifty years' time. Mechanical improvements were n so ineffective as had been represented, and Gre Britain would still be able to keep the place she no occupied amongst the nations of the world.

Mr. A. O. GRANGER said Mr. Siemens's argume would be all right if the coal of other nations had bee mined to the same extent as that of Great Britai but what impressed him in travelling here was th deep coal mining was so prevalent, while in t United States, particularly in Ohio, Kentuck Tennessee, and Alabama, where there was a coa field 1,000 miles in length, and of an average wid of at least 50 miles, the average depth was practical above the water level, with veins of coal from 2 fe up to 6 feet or 8 feet in thickness. That offered enormous future for cheap coal. They were accustomed to believe that commercial suprema was closely connected with cheap coal. The southe parts of the United States would, he believed, be t centre of the coming empire, as it had not only che coal, but also cheap iron.

Mr. T. R. GAINSFORD said Professor Hull remarked hat he did not know of any possible substitute for coal ts a means of producing electricity in this country, but ie would remind him that an important private Bill n Parliament this Session was one for utilising the vater in the Highlands of Scotland for the generation of electricity, and it was not at all unlikely that hat Bill would become law this year.

Professor HULL said his observation did not apply o Scotland.

Mr. FORSTER BROWN, in reply, said he did not mention Australia because it was an isolated continent, and, lthough it possessed large coal-fields, did not appear ikely to be a serious competitor at present with England. It was suggested that instead of trying to nake this country last a little longer, the centre of ravity should be removed somewhere else, but lthough the Anglo-Saxon race might hold the coalelds of a distant country, it would not be quite the ame as Great Britain, His idea was to suggest a way y which the home country, which they knew and oved, should be maintained for practically an inefinite period. That was why he put the position so trongly, and did not refer to the fact that the Anglo-axon race was likely, in America or elsewhere, to ccupy the most valuable coal portions of the world. Ie wanted to see if there was any way by which Great ritain herself should still be maintained as the centre. Vith regard to a new source of power, no doubt if e could have a Niagara, or could utilise the falls of ater in the Highlands, or anywhere else, we might et power; or we might get power from the waves; but is point was that having regard to the position of our oal-fields, we could not get power, broadly, to supply ie commerce of the nation, except from cheap coal. rofessor Hull suggested they might do without coal, id quoted the case of Holland; but when Holland as a great country, traffic on the seas was accomished by means of sails; now it was by steam, and ou must have cheap coal to insure maritime supreacy. He thought Mr. Siemens sailed round the uestion a good deal. All economy in the consumption coal extended its use. Twenty-five, thirty, or forty ars ago, a much larger proportion of coal was used in ery kind of manufacture than is at present; but if you duced the proportion to a minimum, and if your ighbour could supply that minimum at half the st, other things being equal, your neighbour would ke away your trade. Although, in certain industries, e proportion of coal used was small, the industries this country were not confined to one or two ings, and some of them, such as the proction of pig-iron in blast furnaces, required a rge consumption of fuel; it was not simply a uestion of horse-power. The proposal would able the cost of labour and living to be reduced, us reducing the cost of the part of manufacturing st not applicable to fuel. It was suggested that ere would be ways of getting over the difficulties of deep working and so on. In a paper which he read at the British Association at Bristol, he had dealt with this part of the subject, and he did not think it wise to refer to it again; but whatever sort of machinery you used and however economical it might be, it would be less costly to obtain coal from a 6 ft. seam than from one of only 2 ft. With regard to temperature, he did not see how it was practicable to get over the natural increase of temperature due to the depth; it must increase the cost. The point of his paper was that it was possible by a little forbearance by buying the railways instead of paying off the National Debt, to extend the period of national prosperity by two to three hundred years. The other alternative seemed to assume there was nothing for it if his figures were correct than to see our prosperity come to an end in fifty or sixty years, or whatever the time might be. He did not think that was what Englishmen ought to do if, as he had pointed out, a far better course was practicable.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Forster Brown, which was carried unanimously.

Obituary.

C. WASHINGTON EVES, C.M.G.—Mr. Charles Washington Eves, who had been a member of the Society of Arts since 1887, died suddenly at his residence in Highbury New-park, on the 20th inst. He was born in 1838, and was educated in London, at St. Omer, and Bonn. He was long identified with the affairs of the West Indies. He acted as Hon. Commissioner for Jamaica at the Colonial and Indian Exhibition in 1886, and represented the colony at the Colonial Conference in 1887. He was chairman of the London Committee of the Jamaica Exhibition in 1891. He was a member of the Executive Council of Imperial Institute, and Hon. Colonel of the 1st Middlesex (Victoria and St. George's) Rifles. He read a paper on Jamaica and its forthcoming Exhibition before the Foreign and Colonial Section of the Society, on May 15th, 1890, and he took the chair at the meeting in December, 1896, when Mr. Frank Cundall read a paper on "Jamaica in the Past and Present."

General Notes.

ROMAN BUILDINGS.—The building trades special number of the *Illustrated Carpenter and Builder* (April 21st) contains an article on the "High Buildings of the Ancients," in which the discovery made by Professor Lanciani, that there were building laws in Rome before the Christian era, is alluded to.

There are frequent references by the Roman historians, orators, and poets, to the enormous height of the tenement buildings of Rome. In the reign of Augustus, a law was promulgated by the Senate which fixed the height of new structures at 60 feet on the street front, without making any allusion to the height in the rear, and in consequence these tenement buildings often rose several storeys higher in the rear than in the front. The number of storeys on the street front of some of these buildings were from ten to twelve, with fourteen or fifteen in the rear. The height of these Roman buildings was entirely irrespective of the width of the street.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MAY 3.—"Ætheric Telegraphy." By W. H. PREECE, C.B., F.R.S.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MAY 2.—Mr. Burton's paper on "Maiolica," announced for this evening, is unavoidably postponed.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

PROF. HENRY R. PROCTER, F.I.C., "Leather Manufacture." Four Lectures.

LECTURE III.—MAY 1.

Physics of tanning—Theory of the pickling process—Mineral tannages—Tawing with alumina salts—Chrome tanning—Heinzerling process—Schultz or "two-bath" process—Basic or "one-bath" process—Iron tanning.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 1... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Henry R. Procter, "Leather Manufacture." (Lecture III.)

Royal Institution, Albemarle-street, W., 5 p.m. Annual General Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. James D. Roots, "Petroleum Motor Vehicles."

British Architects, 9, Conduit-street, W., 8 p.m. Annual General Meeting.

Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Prof. T. McK. Hughes, "Nationality."

TUESDAY, MAY 2...Royal Institution, Albemarle-street W., 3 p.m. Prof. Silvanus P. Thompson, "Electric Eddy-Currents." (Lecture I.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. F. Ameghino, "Sur le Type primitif des Molaires plexodontes des Mammifères." 2. Mr. W. E. de Winton, "Notes on Chinese Mammals, principally from the Western Province of Sechuen." 3. Mr. Edgar A. Smith, "A Collection of Land-Shells from British Central Africa."

WEDNESDAY, MAY 3...SOCIETY OF ARTS, John-street, W.C., 8 p.m. Mr. W. H. Preece, "Ætheric Telegraphy."

United Service Institution, Whitehall, S.W., 3 p.m. Sir Richard Temple, "The Strategic Relation of Persia to British Interests."

Archæological Association 32, Sackville-street, W., 4½ p.m. Annual Meeting.

Obstetrical, 20, Hanover-square, W., 8 p.m.

North-East Coast Institute of Engineers and Shipbuilders, Westgate road, Newcastle-upon-Tyne, 7½ p.m. 1. Discussion on Mr. E. C. Chaston's paper, "The Manufacture of Shafting for Screw Steamers," and Mr. F. Claws's paper, "The Increasing frequency of Failure of Propeller Shaft." 2. W. E. Cowens, "Shop and General Establishment Charges in Engineering Works, and their Relation to Costs and Estimates."

THURSDAY, MAY 4.. Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. F. G. Parsons, "The Position of Anomalurus as indicated by its Myology." 2. Miss Ethel S. Barton, "Notheia anomala, Harv. et Bail." 3. Mr. G. S. West, "Variation in the Desmidiæ."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. H. B. Dixon and E. J. Russell, "The Combustion of Carbon Disulpdide." 2. Messrs. H. B. Dixon and J. D. Peterkin, "The Action of Nitric Oxide or Nitrogen Peroxide." 3. Mr. H. B. Dixon, "The Mode of Burning of Carbon" 4. Messrs. Henry J. Horstman Fenton and Henry Jackson, "Crystalline Glycollic Aldehyde." 5. Messrs. Orme Masson and B. D. Steele, "The Blue Salt of Fehling's Solution and other Cupro-tartrates." 6. Dr. S. B. Schryver, "The Preparation of Acid Phenolic Salts of Dibasic Acids." 7. Mr. B. W. Allen, "The Maximum Pressure of Naphthalene Vapour."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lewis F. Day, "Embroidery." (Lecture I.)

Electrical Engineers (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Mr. P. V. McMahon, "Electric Locomotives in Practice and Tractive Resistance to Tunnels, with Notes on Electric Locomotive Design."

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Annual Meeting. 1. Presidential Address. 2. Reading of papers and discussions.

FRIDAY, MAY 5...Royal Institution, Albemarle-street, W., [illegible] p.m., Weekly Meeting, 9 p.m., Dr. W. J. Russell, "Pictures produced on Photographic Plates in the Dark."

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Annual Meeting. Paper and discussions continued.

Geologists' Association, University College, W.C., 8 p.m.

Junior Engineering, Westminster Palace - hotel, S.W., 8 p.m. Mr. W. H. Owston, "Gun Construction."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MAY 6...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. L. Brown, "To Iceland in Search of Health." (Lecture I.)

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FRIDAY, MAY 5, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, 20th June. The reception will commence at 9 p.m.

The following portions of the Museum will be open :—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery ; on the First Floor—the East and West Corridors, and the Lecture Room.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the *Conversazione*. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary) or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

CANTOR LECTURES.

On Monday evening, 1st instant, Professor Henry R. Procter, F.I.C., delivered the third lecture of his course on "Leather Manufacture."

The lectures will be published in the *Journal* during the summer recess.

PRACTICAL EXAMINATIONS IN MUSIC.

The Practical Examinations in Vocal and Instrumental Music will be conducted by Mr. John Farmer, Balliol College, Oxford, and Director of the Harrow Music School, Examiner, and Mr. Ernest Walker, M.A., Mus.Doc., Oxon, and Mr. Burnham Horner, Assistant Examiners, at the House of the Society, and will commence on Monday, 26th June.

The last day for receiving applications is Saturday, 12th May.

Particulars can be obtained on application to the Secretary.

Proceedings of the Society.

NINETEENTH ORDINARY MEETING.

Wednesday, May 3, 1899 ; Sir Juland Danvers, K.C.S.I., in the chair.

The following candidates were proposed for election as members of the Society :—

Chatterjee, Sasi Bhusan, 8, Dixon's-lane, Calcutta.
Cuningham, Sir William John, K.C.S.I., East India United Service Club, 16, St. James's-square, S.W.
Johnston, J. Lawson, Kingswood, Sydenham-hill, S.E.

The following candidates were balloted for and duly elected members of the Society :—

Greene, Frank Arnold, 22, Martin's-lane, Cannon-street, E.C.
Hall, John Slocombe, 45, Chatsworth-road, Brondesbury, N.W.
Molloy, Harry J., care of Messrs. W. Watson and Co., 7, Waterloo-place, S.W.
Pakenham-Mahon, Captain Henry, D.L., 35, St. George's-road, Eccelston-square, S.W., and Strokestown, Ireland.
Wiseman, William Thomas, Cromwell-house, 160, Stockwell-park-road, S.W.

The paper read was—

ÆTHERIC TELEGRAPHY.

By W. H. Preece, C.B., F.R.S.

On the 21st of February, 1894, I read a paper in this room on "Electric Signalling without Wires," in which I attempted to show how at that time "we were gradually by patient

plodding creeping along towards the period when I hope we shall be able to make real practical use of electro-magnetic disturbances." To-night I purpose to show you that we have attained that object. The experimental stage in wireless telegraphy had been passed in 1894 and we were then entering the commercial stage. I said in that paper: "The conditions are now so clear that given the localities between which it is desirable to communicate it is a mere matter of calculation to show what has to be done. It would be quite easy to speak between France and England across the Straits of Dover."

In March, 1895, the cable connecting the Island of Mull with the mainland was broken, and as some time might elapse before the repairing ship could reach the locality communication was set up with that island by my system of ætheric telegraphy. A gutta-percha covered copper wire, $1\frac{1}{2}$ miles long, was specially laid along the Argyllshire coast, and the ordinary iron wire connecting Craignure and Aros in Mull was used. The mean distance separating the two wires was about three miles. There was no difficulty in communicating. Public and Press messages were regularly transmitted until the cable was repaired. It created as much sensation at the time as Mr. Marconi's recent experiments from Dover to Boulogne have excited during the past week or two. Signalling through space without wires became a practical operation.

In 1896 a cable was laid for the War Department from Lavernock near Cardiff to the island of Flatholm in the Bristol channel. There are two important forts protecting the channel at these two points. The cable crossed a very much frequented route and an anchorage ground. It was speedily broken. The communication being very necessary, the cable was replaced early in 1898 by an ætheric telegraph, and since that time to the present day this communication has been maintained uninterruptedly, and is in daily use by the soldiers who work it.

I will show you the principle on which it is worked. It is due to the formation of electro-magnetic waves of induction. These waves, as they rise and fall, set up electro-magnetic disturbances in conductors in their neighbourhood, and if these conductors form part of a telephone circuit, musical sounds are produced in the telephone if the disturbances are rhythmical. Vibrations of about 400 per second give the most pleasing and effective note, and when the note is broken up into dots and dashes, messages can be sent by the Morse alphabet.

You will perceive how simply the thing works, but you will also learn how rapidly the effects observed diminish as the distance increases when we use coils. The law regulating this distance is very simple. Indeed, in practice, and when the distance between the coils is considerable compared with the diameter of the coils, the effect diminishes as the cube of the distance. The distance to which communication is possible by overhead wires across a channel is limited by the length of the wire on each side, and by the delicacy of the receiving apparatus.

Attention is called at Lavernock and Flatholm by a very ingenious invention of Mr. Sydney Evershed. The vibratory currents are not used to produce sound, but they set up at the distant station vibratory movements in two loops of fine wire oscillating in a strong magnetic field at the low frequency of 16 per second in opposite phases. When these loops are properly timed, and the vibrations have sufficient amplitude, they make contact, complete a local circuit, and ring a trembler-bell.

Professor Oliver Lodge has devised another mode of calling attention. He proposes to produce loud sounds by making the coil of the telephone vibratory, instead of using an iron diaphragm, and transmitting these vibrations directly to a sound-board. The magnetic field in which the coil vibrates is produced by a powerful horse-shoe magnet. The Post Office is going to give this new call a practical trial. It is hoped that it will develop into a new receiver.

I am by no means satisfied that we have reached finality in this form of ætheric telegraphy. There is vast room for improvement. We can increase the energy emitted at the sending end, we can enlarge the primary circuit by using heavier copper and increasing the size of the coil. We can vary the frequency of the currents and also the character of the receiving apparatus. Indeed, there is a potentiality of research and invention in this field for those who have leisure and inclination. If it had any serious commercial value before it it would doubtless be exploited by enterprising manufacturers. Perhaps unfortunately, I did not patent it, and I have therefore no financial interest in it. The Post Office up to the present have used it practically only twice. It failed to act through sea-water, owing to the rapid absorption of the energy by the sea, and therefore it failed to be useful for light-

ships; but in the mean time a new method of doing the same thing in another way has been devised by Mr. Marconi, which has created a great sensation and to which I must now refer.

Instead of using electro-magnetic waves of low frequency—400 per second—as I do, he uses Hertzian waves of very high frequency, probably of as many millions per second. He employs an ordinary induction coil such as is used to illuminate vacuum tubes or to excite Röntgen rays. The primary circuit contains an accumulator of 8 cells and a Morse key which can direct through it currents of long and short duration so as to form the Morse alphabet, as in ordinary telegraphy, to send messages. The secondary circuit ends in a radiator composed of two metallic spheres, between which sparks pass. One sphere is connected to the earth and the other to a vertical wire, whose length varies with the square root of the distance through which it is desirable to communicate. This wire is suspended by a pole or mast. Each spark is composed of extremely rapid oscillations of electricity, setting up those electric waves which are known as Hertzian, though they ought to be called Maxwellian, for it was Maxwell who indicated their existence while Hertz experimentally detected their presence and showed us how to measure them. By this apparatus every depression of the key causes rays of electric waves to be emitted through the æther in every direction from the radiator as long as the key is held down. Thus those electric waves are transmitted through space exactly in the same way as light waves, and they follow precisely the same laws. Messages flashed by the heliograph from the Himalayas to the plains are signalled in the same way and by the same medium as Marconi's messages across the Straits of Dover. The first recorded message from Agamemnon to Clytemnestra, announcing the fall of Troy, was sent by the same agency. There is nothing wonderful in this. The wonder is that these electric waves should be detected at great distances through all weathers and seasons, during day and night, and in spite of fog, and snow, and rain.

They are detected by a very simple apparatus. It is called a coherer, and it forms a telegraphic relay. A small glass tube, about 1½ inches long, has inserted in it two silver pole-pieces which tightly fit the tube, but which are separated from each other by a space of about the fiftieth of one inch. This space is filled by a mixture of fine nickel and silver filings with just a trace of mercury. The pole-pieces have wires attached to them which enable the tube to form part of a circuit and which are sealed in the tube when the latter has been exhausted. In its normal condition this metallic powder is virtually an insulator. The particles very slightly touch each other—so slightly that no current passes. They lie higgledy-piggledy, anyhow, in disorder. But let them be placed in an electric field, let electric waves pass through them: they are instantly "polarised;" they are installed in marshal array; their mutual contact is increased; they are subjected to pressure; they "cohere," as Professor Oliver Lodge expresses it; they become a conductor, and an electric current passes if the coherer forms part of the circuit of a local battery. They will continue to act as a conductor until they are "decohered" or restored to their normal insulating condition by mechanical shaking. Mr. Marconi causes a small hammer to strike the glass by the very current the coherer has caused to pass. If the waves have ceased, the tube is instantly decohered. If the waves continue there is no apparent decoherence. This current can at the same time emit either a sound or record signals on paper by ink which in each case can be read. One side of the coherer is connected to a vertical collecting conductor similar to the transmitting conductor, and the other side is connected to the earth. The coherer is an extremely reliable instrument—stable and certain in its action. I have one given to me by Mr. Marconi in 1897 that has never failed to act. I am using it to-night.

It will be seen that the apparatus is characterised by extreme simplicity. The vertical conductor is common to the transmitter and the receiver. At each terminal there must be both transmitting and receiving apparatus, but the effect is improved if the receiving wire be thin and the transmitting wire thick. When signalling from A to B the vertical conductor at A becomes a wing of the radiator, while that at B is a wing of the coherer. The reverse takes place when signalling from B to A. The coherer is protected from the influence of its own radiator by being encased in an iron shield.

The rays can be directed in any given direction by parabolic reflection, but this is effective for only short distances, for a long vertical conductor cannot be used with reflectors. For long distances, tuning or syntonising is the most probable effective mode of securing secrecy;

but Mr. Marconi is still in the experimental stage in this branch of the subject. Syntony is attained when the transmitted impulses of a vibration recur in the same period as the natural period of vibration of the receiver, and thus increase the amplitude of its vibration. When we sing any particular note into a piano the strings of the piano emit only the same note that the voice sounded.

The vertical conductor is an essential feature of Mr. Marconi's system. It determines the distance to which signals can be transmitted. A conductor 20 feet high will signal well to a distance of a mile, 40 feet to 4 miles, 60 feet to 9 miles, 100 feet to 25 miles, and 120 feet to 36 miles. The height of the conductors used in the Boulogne experiment is 150 feet; those used between Alum Bay, in the Isle of Wight, and Poole, a distance of 18 miles, 80 feet high. The law as determined by experiment is this, that the distance increases as the product of two vertical conductors of different heights. This of course is the above law of the square when the lengths of the two conductors are alike.

The effects are distinctly best when signalling across the clear space covering the sea. The sea, like a sheet of metal, reflects these waves, but what does the irregular surface of the earth do? Mr. Marconi has obtained very satisfactory signals between positions which have been screened from each other by hills. French officers on board the *Ibis* at Sangatte, near Calais, on Monday succeeded in speaking to Wimereux, 20 miles away, over Cape Grisnez, a lofty promontory. We do not know at present much about the absorbing influence of the earth upon electric waves. There is room for experiment here. Indeed, the whole subject bristles with new fields for research. It is a misfortune that our physicists have done so little in this direction. Many of them seem to think that there is more importance in discovering priority of invention than in making an invention itself.

Mr. Marconi has been very busy in experimenting between the Isle of Wight and Bournemouth, and with moving ships in the Solent. He maintained communication between the Queen at Osborne House and the Prince of Wales on board the Royal Yacht *Osborne*. The proceedings of the yachts in the Kingstown regatta of July last year were signalled from a following steamer, and regularly printed every evening in the *Daily Express* of Dublin. Lloyd's signalling station at Rathlin Island, in the north of Ireland, was placed in communication with Ballycastle. The two places are 7½ miles apart. On the 27th March communication was made through a distance of 30 miles between the South Foreland and Wimereux, near Boulogne. Communication has also been established and continuously maintained between the South Foreland, near Dover, and the East Goodwin Lightship, a distance of 12 miles. There was a collision on Friday last between a steamship and this lightship during a thick fog. The fact was immediately communicated to the shore. Fortunately the damage was slight, but, of course, the most was made of such a stroke of luck. Although I had watched and assisted Mr. Marconi in his experiments from his first introduction to me in 1896, and the Postmaster-General had taken the greatest interest in the system, it was thought that independent experiments should be made to confirm our opinion of the practicability of the system. They were made in September, 1897, near Dover. Mr. Marconi's results were confirmed. I reported on the practicability of the system, and the Wireless Telegraph Company, who had secured Mr. Marconi's services and his inventions, were informed that they could connect Sark with Guernsey and the Post Office would open Sark as a public office. They were also informed that the Board of Trade and the Post Office, with the consent of the Trinity House, would be glad if they would connect the South Sand Head Lightship with Dover. Neither of these extensions have yet been done. The company preferred to experiment elsewhere, as I have narrated, to prove what was not necessary to be proved that it was possible to signal across the Straits of Dover, and to show that great distances could be connected. The result is that for nearly two years after its practicability was affirmed, not one single independent commercial circuit exists. The operations of the Wireless Telegraph Company are mysterious and inscrutable.

Captain Jackson, R.N., in December, 1895, commenced at Plymouth working in the same direction, and he succeeded in getting Morse signals through space before he knew anything of Marconi or his system. His reports to the Admiralty, however, were confidential. Had they been published he would have anticipated Mr. Marconi.

When Mr. Marconi was showing the working at the South Foreland to the officials of the Post Office, he received a sharp shock. There was atmospheric electricity about, and Mr.

Marconi repeated Franklin's experience. Sharp sparks were elicited from this miniature lightning, and at the same time erratic signals were observable at Boulogne. The speaking to Boulogne was not interfered with. The officers on board H.M.S. *Vernon* at Portsmouth one day observed similar disturbances, and obtained distinctly the letters A R E. Was this due to Mr. Marconi's experiments at the South Foreland, or was it due to atmospheric electricity? I think the latter, for I have frequently read letters, especially R, on Morse telegraphs when lightning was about.

There can be no question of the commercial value of the system for lightships, isolated lighthouses, shipping generally, and for naval and military purposes, but for commercial uses, such as telegraph communication with France, the system is at present nowhere. A single cable to France could transmit 2,500 words a minute without any difficulty. A single Marconi circuit could not transmit more than 20 words a minute. It is not wanted in this direction. Its name has lead to the popular illusion that the poles and wires which disfigure our house-tops will disappear, but there is no evidence at present that a single wire can be dispensed with. It may add to our systems at work. It cannot diminish the number of circuits at work. There may be many outlying islands that can be connected to the mainland, but this can be equally effective by my own electro-magnetic system. It must not be forgotten that this system of mine is in active practical use, and that its use can be largely extended. It is also open to all, and is not restricted by patent rights. It is, perhaps, unfortunately for me, not in the hands of an enterprising band of capitalists. If it were, it would not have been so soon forgotten. Wireless telegraphy is many years old. It is capable of great improvement, and if an electro-magnetic receiver can be devised as sensitive as the coherer it would work to equal distances, for the waves in each case extend precisely as far in the one case as in the other. Now we require parallel wires that extend to some distance on each side of a channel—a more sensitive magnetic receiver would reduce this to very short lengths. Other minds are at work on the subject.

I have not sufficient leisure to devote the requisite time to develop Ætheric Telegraphy, either on my own plan or on that of Mr. Marconi, but it has a potentiality of public use that is far beyond the dreams of newspaper writers.

Mr. Marconi is to be very sincerely congratulated on the success of his experiments. He has attracted the attention of the public to a very fascinating field of electrical development, and thereby has indirectly served the progress of scientific education.

DISCUSSION.

Mr. A. G. Low asked if a similar system of telegraphy was not tried, some years ago, by a gentleman from Dundee.

Mr. Preece said there was a Mr. Lindsay, of Dundee, who used the water of the river Tay to complete his circuit. He came to London in 1854 or 1855, and submitted his invention to the Electric Telegraph Company, and the trial experiments were left in his hands. He had the pleasure of experimenting with Mr. Lindsay's plan across a large tank specially constructed for the purpose. It was merely a repetition of a plan suggested by Mr. Vail and Mr. Morse, as far back as 1845. They then tried to communicate across the Susquehanna; but it was not wireless telegraphy, it was simply utilising the conductivity of water to complete the circuit.

Mr. Praed inquired how, in the Marconi system, the long wires made the messages more distinct. He could understand the use of long wires in the magnetic circuit, but he did not understand the use of the perpendicular conductors, as in that case it was not a closed circuit.

Mr. Preece said in the electro-magnetic system, the wire was horizontal, and the electro-magnetic lines of force were rings round the conductor, the wave front being horizontal and passing into space in a horizontal direction. The receiver must, therefore, be horizontal also, in order that it might be cut by as many lines of force as possible. In the other case the lines of force were electro-static, and at right angles to the lines of electro-magnetic force and to the conductor. Therefore, in order to secure the greatest number of lines, the transmitting wire must be perpendicular, and the receiver also. The electro-magnetic system dealt with currents, in which case there must be a closed circuit, but with the Hertzian waves there was no circuit; they were propagated in all directions perpendicular to the wire.

Mr. H. Fentum Phillips asked what current was used. He understood that Mr. Marconi used accumulators, but that Professor Oliver Lodge had used dry cells. Would dry or Leclanché cells be equally efficient in places where accumulators could not be obtained?

Mr. PREECE said it was a matter of indifference. You required a certain current through the primary wire, which on the present occasion was obtained from eight secondary cells. In the practical line established between Lavernock and Flatholm, dry cells were used. At the South Foreland, Mr. Marconi used 48 dry cells, joined up in four parallel sets of 12 each.

Mr. COLE asked if any figures could be given as to the length of wire required for a given distance.

Mr. PREECE said the law seemed to be that the best effect was produced when the length of line on each side was equal to the distance across the Channel in the electro-magnetic system. The law of distance was given mathematically in the proceedings of the Institution of Electrical Engineers, when papers by Professor Lodge, Mr. Evershed, and himself were read, but he did not remember the exact figures.

Lieut.-Colonel ALLAN CUNNINGHAM asked what was the maximum distance to which each system had been worked, and the rate of transmission in each. Also if the reflectors used for the Hertzian waves were of metal and polished; and as they were said to be reflected from the surface of the sea, whether this had been more marked, as one would expect in calm weather.

Mr. PREECE said he would take the last question first. He was not aware that any observations had been made in that direction, but it was an interesting point, and they should certainly be made. The reflectors used were of copper, nickel-plated, and polished; they must be metallic. With regard to a comparison of the two systems, he did not wish to raise that question at all. The Marconi system had been wonderfully successful for much greater distances than had been expected. The distance at Lavernock was about $3\frac{1}{3}$ miles, but he did not think there would be any difficulty in going 30 miles if you had a proper length of wire. The great advantage of the Marconi system was that you could cross the distance without so much wire on each side. For lighthouses and lightships the only practical system was the Marconi.

Mr. CHARLES BRIGHT said there could be no doubt that the Wireless Telegraph Company would be doing more useful work if it applied itself to establishing communication with lightships and lighthouses, which was the principal practical direction in which ætheric telegraphy could be applied. What they were doing across the Channel was very interesting to newspaper readers, but seeing that the Post-office and the Board of Trade had invited them to establish communication with lightships, it was a great pity they did not set about it. He believed we were a long way behind Denmark, for instance, in the matter of coast telegraphic communication, and, at any rate, more communication would be very useful, and it was very difficult to establish cable connections with such cases.

Mr. E. TREMLETT CARTER asked whether, in the experiments conducted near Cape Grisnez, Mr. Preece considered that the waves passed over the hill and down again, or whether they went straight through it. He could not see why they should be deflected upwards and then down again on the other side; and he was rather inclined to believe that they travelled in straight lines. A conclusive test of this question might be made by putting a transmitting device in a very deep mine, and having the receiving apparatus on the surface, so that the waves would have to pass through a large mass of rocky matter. The point was of some importance with reference to the question of long distance signalling. If they had to signal from London to New York the waves must either follow the curvature of the earth, or must go in straight lines at a tangent to the surface, when they would miss New York altogether, or they must go through a considerable chord of the earth's map, where they might be partially absorbed.

Mr. GAVEY said he had had the honour of being closely associated with Mr. Preece in many of these experiments, but he could add very little to what he had said. One incident, however, he might mention which had not been referred to. They were carrying out a series of electro-magnetic experiments across Loch Ness, and it occurred to him, after having signalled by the Morse alphabet, to try and speak through the telephone. They accordingly connected telephones with the two wires and spoke into them, and the voices were heard on the other side of the lake just as clearly as if they had been connected by wires, and not only the voices, but laughter, and other sounds in the neighbourhood of the telephone.

Mr. PREECE, in reply to a further question, said he believed the vacuum in the coherer was brought down to 4 m.m. He did not think any attempt was made to vary the degree of vacuum according to the distance, but he could not speak with authority on that point.

Mr. LEON GASTER expressed the satisfaction it had given him to hear Mr. Preece's explanation, and his belief that the system he had put in practice could be much improved. He should like to know what amount of power was required to work the two systems, and to what extent the system of reflectors could be utilised to send the waves forward in straight lines.

Mr. BRABY asked what was the difference in the effect produced by using four balls instead of two.

Mr. SHOOLBRED asked what exact result was produced by increasing the height of the wire.

Mr. BOULT asked how the vertical wire was attached to the apparatus.

Mr. PREECE said it was attached to the coherer at one end, the other end was connected to earth.

The CHAIRMAN then proposed a vote of thanks to Mr. Preece. The subject was one full of marvel and mystery, but he had explained it as clearly as possible, and had been able to do so all the better from having personally worked at it for so many years.

The vote of thanks having been carried unanimously,

Mr. PREECE, in reply, said Mr. Bright had made a somewhat invidious comparison between the coast communication in this country and in Denmark; and he did not think Mr. Bright could have been in that country. He had, and he went there as a member of the Royal Commission which dealt with electric communication with lighthouses and lightships, to see what was done there. They found it was very little—practically almost nothing. He never could understand how people who took an interest in this question could write to newspapers about it, without taking the slightest trouble to ascertain what was done in this country. They jumped to the conclusion that all Government officials were little better than fools, and that the Government itself did not regard the interests of the public, and that nothing was done to meet the wishes of the community. There was scarcely a single lighthouse or lifeboat station round the whole of our coast which was not in direct communication with the postal telegraph system. Thousands of the lifeboat stations were fitted with telephones, and were practically open night and day. A ship could not be wrecked or damaged without immediate information being sent to the place where the lifeboat was kept. There was only one case where that was not done, and that was in connection with the lightships; but the Government were now spending some thousands a year in maintaining electric connection with light-ships, and it was because there was such a difficulty in doing this by cable that they were paying so much attention to ætheric telegraphy. He had had a perfectly free hand to experiment, and had never been stinted in his expenditure for this purpose. He could not answer Mr. Carter's question with regard to the signalling over the hill at Grisnez, as he had not experimented sufficiently, but his theory was that the lines of force were curvilinear and went over the hill. They knew by experiment that the earth had a serious absorbing effect on the waves, as they could communicate much farther across sea than across the land—nearly twice as far. He hoped now that Mr. Marconi had stations at the Isle of Wight, at Poole, and at the South Foreland, he would be able to experiment in that direction. With regard to the power required for the two systems, it was identically the same. They dealt with two series of lines of force, electro-magnetic and electro-static, but it was a well-known principle in the theory of electricity that the amount of energy consumed in those two series of forces was the same. He could not answer the question about the use of four balls instead of two; he could only say that Mr. Marconi had found that for long distances, two balls acted as well as Professor Righi's oil, though, he believed, he retained the four in his experiments with reflectors. He could not answer Mr. Shoolbred's question satisfactorily; he could only say that the length was determined by the number of lines of electro-static force you wanted to catch at the receiving end. Whether you used electro-magnet force, or electro-static, it was simply a question of the number of lines of force you could drag into your net.

Miscellaneous.

FLEXIBLE FILMS FOR SPECTROSCOPIC PHOTOGRAPHY.

Sir Norman Lockyer has lately been experimenting, and very successfully, with flexible film, with the idea of adapting it to spectroscopic photography. The large concave Rowland grating which he is now using for his solar spectroscopic photographs has 20,000 lines to the inch ruled on its surface, and is of $21\frac{1}{2}$ feet radius, giving a spectrum of 30 inches long. The focal plane of this grating is of necessity considerably curved, in fact the plane of accurate definition at the edges of the field is about half an inch in front of the similar plane at the centre. It is, therefore, impossible to get a sharp photograph of the whole spectrum on a glass plate, in fact not more than 18 to 20 inches of the spectrum can be brought into focus on the same plane. This difficulty is, of course, got over by the use of a flexible film, which can be bent to the curvature of the field.

A print of one of Sir Norman's photographs, taken with this Rowland concave grating, showing the arc spectrum of iron with a comparison spectrum of the sun from wave length 3,600 to 5,200, is 30 inches long, and must be the longest solar spectrum photographed at a single operation. Sir Norman Lockyer also hopes that by using films, instead of glass plates, at the next solar eclipse, he will be able to obtain an increased number of photographs, owing to the rapidity with which the film can be shifted in the short space of time available for photographic operations. At the last eclipse the photographic work was concentrated on obtaining a series of photographs of the chromosphere both about the time of beginning and end of totality. By careful drill Mr. Fowler and Dr. W. J. S. Lockyer were both able to secure ten photographs at each of these important periods, the time occupied in making each series of ten exposures being 12 seconds. An apparatus for carrying films is also being designed which can be adapted to the spectroscopic cameras at present in use in the laboratory and observatory.

GOLD PRODUCTION IN THE PHILIPPINE ISLANDS.

Gold is found in a vast number of localities in the Archipelago from Northern Luzon to Central Mindanao. In most cases, according to a recent United States report, the gold is detrital, and found in existing water-courses or in stream deposits now deserted by the current. These last are called *alluviones* by the Spaniards. It is said that in Mindanao some of the gravels are in an elevated position and adapted to hydraulic mining. There are no data at hand which intimate decisively the value of any of the placers. They are washed by natives largely with cocoanut shells for pans. In the province of Abra, at the northern end of Luzon, there are placers, and the gravel of the river Abra is auriferous. In Lapanto there are gold quartz veins as well as gravels. Gold is obtained in this province close to the copper mines. In Benguet the gravels of the river Agno carry gold. There is also gold in the province of Bontoc and in Nueva Ecija. The most important of the auriferous provinces is Camarines Norte. Here the townships of Mambulao, Paracale, and Labo are especially well known as gold-producing localities. Mr. Drasche, a well-known German geologist, says that there were 700 natives at work on the rich quartz veins of this place at the time of his visit, about 25 years since. At Paracale there are parallel quarts veins in granite, one of which is 20 feet in width, and contains a chute in which the ore is said to assay 38 ounces of gold per ton. It may be taken that this assay hardly represented an average sample. Besides the localities mentioned, many others of this province have been worked by the natives. The islands of Mindoro, Catanduanes, Sibuyan, Simar, Panay, Zebu, and Bohol are reputed to contain gold, but no exact data are available. At the south end of the small island of Panaon, which is just to the south of Leyte, there are gold quartz veins, one of which has been worked to some extent. It is 6 feet in thickness, and has yielded from 25s. to 29s. per ton. In the island of Mindanao there are two known gold-bearing districts. One of these is in the province of Surigao, where placer and other townships show gravels and veins. The second district is in the province of Misamis. Near the settlement of Imponan and on the Gulf of Macajalar, there are said to be many square kilometres of gravel carrying large quantities of gold, with which is associated platinum. The product of this district was estimated some years since at 150 ounces per month, all extracted by natives, chiefly with cocoanut dishes.

USES OF GLASS.

Early in October of last year, a paving company, of Lyons, began laying in the Rue de la Republique in that city a piece of pavement of ceramo-crystal, ceramic stone, or devitrified glass. The United States Consul in Lyons, in his last report, calls attention to this circumstance, and says that during the months of November and December, 1898, and in January of this year, this pavement has been driven over during all hours of the day and night. It has stood as hard usage as any pavement could be subjected to during that time, and is still in an admirable state of preservation. The glass or ceramic stone pavement is laid in the form of blocks, eight inches square, each block containing sixteen parts in the form of squares. These blocks are so closely fitted together that water cannot pass between them, and the whole pavement looks like one huge chess board. Like all thoroughfares in France, the road bed slopes gently to the curb on each side. Consul Covert gives an interesting account of a visit he paid to the Ceramo Crystal Manufacturing Company's works at the suburban village of Demi-Lune, about six miles from Lyons. The factories cover nearly 8,000 square yards of ground. At the time of his visit the work was stopped while additions were being made to the buildings in the shape of second storeys. In the yards were many tons of broken bottles, which the superintendent of the works stated was their "raw material." On the four sides of a large brick chimney were specimens of ceramo-crystal for buildings and interior decoration, some of the pieces as smooth as highly-polished marble, others being rough, like cut stone, and still others having a surface like common brick. The advantages attributed to this ceramo-crystal by the manufacturers are:—As a pavement, it has greater resistance than stone; it is a poor conductor of cold, and ice will not form upon it readily; dirt will not accumulate upon it as easily as upon stone, and it will not retain microbes; it is more durable than stone, and just as cheap. The Central Architectural Society of France made a report recently on this ceramic stone, of which the following is a brief synopsis:—An officer of the society reported that he had examined a square suitable as a pavement or floor for a stable, a courtyard, or factory; a block imitating polished marble; a block imitating mosaic; and a panel with moulding and ornamentation. He said—"From the various forms in which this material is presented, its use can readily be determined for both practical and decorative purposes. On careful examination, it is found that the Garchey ceramic stone is nothing but glass brought to a special molecular condition. In a certain sense, it constitutes a new substance, which resembles flagstone, granite, or marble. The manufacturer states that with this material he can copy any model that is presented. This new product is obtained from broken glass, heated to a temperature of 1,250°, and compressed in matrices by hydraulic force. The physical transformation of glass is due to devitrification under the Garchey process. The phenomenon of devitrification produces a sort of dissolution, more apparent than real; for, upon chemical analysis, the devitrified glass preserves the identical composition of natural glass. It may be said, then, that devitrified glass possesses all the intrinsic qualities (physical and

chemical) of glass except the transparency, while taking on an entirely different aspect. Furthermore, glass treated under this new method is made to resist crushing, frost, and heavy shocks, and to stand rough wear." This subject is being discussed in the French Press, and is receiving general consideration. An elaborate and exhaustive article in the "Revue des Deux Mondes," for November last, treated the question under the heading of "A Glass House," the writer asserting that a large house, constructed entirely of glass, would be an attractive feature of the Exhibition of 1900. He said that glass could be used for tubes, pipes, vats, tiles, chimneys for factories, and for buildings. Double glass walls in a house would admit of the circulation between them of cold or warm air, thus regulating the temperature. "As to the resistance of such a structure, it would certainly be equal to that of the most solid houses of the day, and it is lighter and less expensive than brick." The glass house or palace which it has been decided to build in the grounds of the Exhibition in 1900 parts of which are now being constructed, is thus described by the writer last quoted:—"The principal façade, in the form of an immense portico, its roof surmounted with spires, and with a winged statue representing light, will be supported by heavy columns. The ground floor, reached by a double flight of stairs, will be used as a great exhibition room. To the right and left will be large glass basins, overhung by grottoes of glass. In the interior of the hall will be five large openings, in which will be represented the five divisions of the globe."

THE SILESIAN CARPET INDUSTRY.

The manufacture of carpets is rapidly becoming an important industry in Silesia, and has its centre at the town of Schmiedeberg. The carpet is an imitation of the Smyrna article, and ranges in price from 12 to 25 marks (12 to 25 shillings) per square metre (10·76 square feet). The process of manufacturing is as follows:—The threads are twisted from German and foreign wool; various wools are used to find the right combination of strength and smoothness. Artificial wool is added to the inferior kinds, and the cheapest qualities are made entirely from the latter material. The wool, of which the thread is to be made, is first placed upon a machine called the "wolf" or "devil," by which it is torn to small pieces. It now proceeds to another machine called the "krempel" or "carding bench," which further completes the work of tearing. At the lower end of this carding bench a kind of drum is located, around which the thick smooth wool finally gathers, to be afterwards taken to the weaving room. Here the wool is twisted by a machine into a two, three, or four-ply thread, according to requirement. This thread is now taken to the dyeing room, where it undergoes a good washing to clean it from all dirty and oily substances. Only real Oriental colours are used in this process. The coloured threads are then cut into small lengths of about 3 centimetres (1·18 inches), each to form the material for single loops. These loops are now sorted by colour into small wooden boxes, and these are handed over to a female labourer called *knüpferin.* The production of the carpet now commences. The United States Consul at Breslau says that the looms in use consist of two side parts connected by iron or wooden bars. The broader the looms the broader these bars and consequently the carpets they produce. The looms have two fronts so that work may be carried on on both sides at the same time. The smallest looms measure 1 metre (39·37 inches), the largest up to 15 metres (49·2 feet). The number of the working women depends upon the size of the carpet to be made. A space of three-fourths of a metre (29·5 inches) is allotted to each of them. Clever and intelligent workers, however, frequently undertake to manage double space. All the girls sit in one row or line and work simultaneously. The top of the loom contains the chain thread of linen or jute, while at the bottom the receptacle—viz., a drum for rolling up the finished article—is to be found. The chain threads are fixed midway between top and bottom of the loom, and serve for binding or for the construction of the carpet. They are passed through the shuttle and afterwards twisted round an iron bar. After this the chain is tightened and a seam made upon which the first row of loops is fixed. As soon as a row of loops has been finished across the whole width, a thick end thread of jute is passed across twice. After each passing, the chain threads are allowed to cross each other, so that they form a firm weave. Another row of loops is then tied, and the edge formed, and so on. The working girls are seated on low wooden stools, having at the height of their head the pattern of the carpet before them which they have to copy. Each has at her side the above-mentioned wooden boxes, containing loops of various colours. The patterns are printed or drawn on paper, and show small squares, each of which indicates a loop, and the colours on the paper correspond with those of the required loops. The girl starts with the first square at the left-hand side at the bottom row, and continues tying to the right so far as her space allows it. As soon as a row of loops has been finished the edge is made in the usual way, and this process is carried on until the whole pattern has been completed. At the finish a seam is added, and the carpet cut off and taken from the drum. The loose wool and the dirt are removed, and the carpet well beaten on the back to loosen the weaving, which has become hard during the process of manufacture. Next, the shearing-machine clips the top five or six times, until a smooth plush-like surface is produced, whereupon the seams are removed and false loops replaced by others, and the carpet is ready for use. The work is entirely done by piece, and a clever, industrious girl naturally earns more than one less capable. The

average wage for a girl amounts to 1·50 marks (1s. 6d.) a day, but the best workers earn as much as 3 marks (3s.). There are about 450 hands employed at Schmiedeberg, and 4,262 carpets, of various colours and size, are turned out per annum. Consul Erdman says that the carpets are such a good imitation of Smyrna goods, that it really takes an expert to distinguish them from the genuine. They are also a good deal cheaper than the Smyrna carpets, and there is naturally a large market for them throughout Germany. They are exported to Austria, Italy, Scandinavia, and Belgium.

TEXTILE INDUSTRY OF JAPAN.

The manufacture of textiles in Japan is not confined to certain localities, but extends by means of hand looms all over the country. The spinning-wheel was formerly in general use, but during the last 20 years it has been almost wholly displaced by spinning mills using machinery. More than 1,000,000 spindles are now thus operated, 47 mills in Japan producing last year an estimated yield of 650,000 bales of yarn of 400 lbs. each. The United States Consul at Hiogo says that more than 200,000 bales will probably be shipped to China during the current year, and the home demand for counts averaging No. 18 will be nearly supplied by the remaining 450,000 bales. Only one of the spinning mills in Japan has imported the machinery necessary for spinning the higher counts above No. 30. The Nippon mill of Osaka has done this, but so far, according to the Consul, has not made a success of it. Higher counts are steadily imported from England, and in greatly increasing quantities, to meet the home demand. When mill hands with greater skill are to be procured in Japan the spinning of the higher counts will increase more rapidly, in order to supply the home market and the demands from China and Korea. Many of the large class of persons formerly employed in spinning by hand are now engaged in weaving textiles on hand looms. It has recently been computed that more than 600,000 hand looms are in use in Japan, and it is stated that they employ 890,000 women and 50,000 men. As these hand looms are generally operated in private houses, giving a home character to the work, it can readily be seen why such slow progress is being made in the introduction of power-weaving machinery. The hand looms now in use are called *battan*, and are an improvement on those formerly used. They cost but about 5 yen (about 10s. 6d.) each, and take up little room in a house, while a power machine would require a separate building, and with the necessary power would cost say nearly 500 yen (about £50). The hand loom will produce about half as much as a power loom, but one person could attend to perhaps four or five of the latter at a time, and thus be able to turn out, say eight or ten times the product with a power loom as with a hand loom. The convenience, however, of having the hand loom in the house, and the difference in its cost, will perhaps be sufficient to delay the introduction of power looms to any great extent for some time to come. The hand looms are hand-made, and are principally used in supplying some 1,000,000 pieces of goods, say 14 inches in width and from 12 to 25 yards in length, for the home market and for export to China and Korea. The Japanese manufacturers are very conservative in their business methods, and manufacture large quantities of goods only on order. The largest silk factory in Japan using power looms is the Kyoto Orimono Kaisha of Kyoto. It imported these machines from France. Silk in its various forms, from the raw material to the finished product, is mainly exported from Yokohama. The industry dates back to an early period, and is to-day in an advanced condition. The exports of manufactured silks from Japan in 1897 amounted in value to about £1,364,000. The manufacture of woollen goods is a new industry in Japan and a small one, as only about 13 per cent. of the woollen tissues used in Japan are made in the country. The raw material is all imported from China, Australia, and London. The four woollen factories of the country are located in Osaka and Tokyo. One is owned and worked by the Imperial Government, and manufactures supplies for the army and navy. Some of the better grades of cotton and woollen yarns are made there, but they are mostly imported. A large proportion of the woollen cloths used are made on hand looms. The first knitting machinery used in Japan was brought from England; some has since come from other countries, and the Japanese have copied all. The machines are of hand power and worked in private houses, from one to five being found in a house. The knitting business is not scattered through the country like weaving, but is concentrated in manufacturing centres, a great deal being done in Osaka. Large quantities of cheap underwear are made in Japan, all from cotton yarn spun in the country. Cotton and woollen yarns used in making the better grades are imported. Not much woollen underwear is used, the demand being confined to the better classes of the Japanese people, who also wear light-weight all-wool with open meshes in summer. This light-weight referred to has been made for soms time in Japan for the Indian market. The Japanese children have lately begun wearing mixed knitted singlets in the central part of Japan. Nearly all the spinning machinery used in Japan still comes from England. The first spinning machines ever used in the country were sent from England. French and German makers have supplied a considerable quantity of the silk and woollen weaving machinery.

VITICULTURE IN SPAIN.

In the district of Cadiz, including Jerez, Port St Mary, Chiclana, &c., the vineyards gave in 1898 a worse crop as regards quantity than ever, though the

quality of the grape juice or *mosto* appears to have been more satisfactory than had been anticipated. The decrease in the crop is, according to Consul Vecqueray, due to the continued ravages made by the phylloxera, which now seems to have attacked the vineyards on sandy soil, which have up to recently been more or less free from the disease—those on the *albariza* or white clay soil, having principally been affected hitherto. As examples of the evil results due to the phylloxera, it may be mentioned that one vineyard which formerly produced up to 250 butts of 500 litres (500 litres = 880 Imperial gallons), only gave in 1898 about 70 butts; another gave only 15 butts as against 120 butts in the previous year, and a third which produced 138 butts in 1896 and 115 butts in 1897, gave in 1898 no more than 34 butts. Naturally the vineyard proprietors lose very heavily from this reduction in the produce of their vines, but they feel the loss all the more because they have to pay the same heavy duty as formerly on their plantations. In the course of the past year a Commission of vineyard proprietors went to Madrid to beg the Minister to either take this duty off altogether, or at any rate to limit it to the output of the vineyard. It is not yet known how far this Commission obtained its object. In order to resist the phylloxera plague, many vineyard proprietors have now adopted the plan of grafting the principal stems of their vines into stocks of the American vine. A few proprietors had already made this attempt in previous years, and during the past year reaped a satisfactory result, inasmuch as they found that not only the character of the Spanish wine was unaltered by the process, but also the produce of the vines was greater. The process is a very expensive one, and some vineyard owners may not be able to afford to attempt it. Consul Vecqueray has been informed that it costs about 1,000 pesetas (£40) for each *aranzada* (about $1\frac{3}{4}$ acres), including the purchase of the plants, and that some 200 *aranzadas* were so planted in 1898. There is a provincial house in the Jerez district which supplies American vines of different kinds, and has sold several thousands in the course of the last two years. A vineyard proprietor purchases a few of these vines and plants them on a small portion of his own vineyard. In the following year he is able to take shoots from these vines and replant them, again grafting into them the Spanish vines. Thus, year by year, he will extend the planting of the American vine to the whole of his vineyard, but three years are required before the American vine, into which the Spanish stem has been grafted, will produce, and this, of course, adds to the loss and expense incurred by the proprietor. No other remedy, however, seems to be effective, and to prevent the sherry trade becoming totally extinct, it will probably be adopted by all vineyard proprietors. The disease shows its capriciousness by attacking chiefly the vines that produce good sound wines, leaving those that produce common wines almost untouched; and in the Jerez district alone, out of 8,000 hectares (19,700 acres) planted with vines, it can be calculated that no less than 5,000 hectares (12,300 acres) are affected. Still the connoisseur of sherry need have no fear that he will not be able to obtain the genuine old wine of Jerez for many years to come, as there are considerable stocks of good, useful wines still to draw upon in the various Bodegas.

General Notes.

ALGERIAN WINE PRODUCTION.—The figures relating to the production of wine in Algeria show the steadily increasing importance of the industry. A very large proportion of the total production is received in France, where it is used in combination with other wines to produce the article which the trade requires. The yield of 1898 is given as 5,221,700 hectolitres, or, in round figures, 115,000,000 gallons. The area of the vineyards reached a total of 123,960 hectares, or 306,000 acres. In 1880 the production was 12,000,000 gallons; in 1888, 70,000,000 gallons; and in 1897, 113,000,000 gallons.

ELECTRIC STREET RAILWAYS IN GERMANY.—Germany is at present making rapid strides in the construction of electric street railways, and in the smaller cities a number of such railways are either in progress of construction or are being planned. In Meissen, Weimar, and Eisleben the roads are being built. The following cities, according to Consul Harris, of Eibenstock, are planning the immediate construction of electric plants and electric street railroads:—Pforzheim, Trier, Ratisbon, Colmar, Jena, Kaiserslautern, and Worms. There are no doubt other cities that are preparing to do the same thing. The population of those above mentioned varies from 15,000 to 50,000.

COPPER IN BOLIVIA.—The Bolivian copper formations extend in an almost uninterrupted line from south to north, following the general direction of the eastern chain of the Andes. The only beds worked to-day are those of Corocoro, upon the high plateau of Titicaca. The distinctive feature of these beds is the abundance of native copper, in forms varying from microscopic grains to great masses weighing several tons; in wealth they rank second only to those of Lake Superior. The most primitive and imperfect methods of working these beds are employed. The scarcity of fuel does not permit fusion on a large scale of the various combinations of the metal. As a matter of fact there are only two furnaces at Corocoro. The ore is broken with hammers by women, passed through mills worked by hand or by hydraulic power, undergoes two washings in inclined trenches, and finally is dried either by the sun or by artificial heat. The ore produced is of a standard of not less than 70 per cent. The quantity extracted in 1897, as given by the four companies of Corocoro, was 2,912,566

kilogrammes (6,421,000 lbs.). The Bolivian Government taxes every Spanish quintal (101 lbs.) of ore about 4½d. The net cost of a Spanish quintal of copper at Corocoro is about 12s.

PRESERVATION OF RUBBER TREES IN THE CONGO FREE STATE.—The Government of the Congo Free State, with the object of preventing the threatened destruction of the indiarubber trees in that country has promulgated a decree by which it is provided that for every ton of rubber yielded annually, there shall be planted not less than 150 trees. A bureau of control of rubber forests is created, and is charged with the enforcement of the decree of 1892, which prohibits the gathering of rubber in any other mode than through incisions in the bark. Infractions of this new decree, which bears date of January 5th, 1899, are punishable by a fine up to 10,000 francs (£400) or imprisonment. Employers and directors of corporations are held personally responsible for the acts of their subordinates. Guide books for the cultivation of rubber are furnished by the District Commissioners on request, and agricultural inspectors will be placed temporarily at the service of private owners.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

MAY 10.—"Fruit Growing in Kent." By GEORGE BUNYARD. SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., will preside.

MAY 17.—"The Law of Trade Marks." By J. E. EVANS-JACKSON.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MAY 11.—"Agrarian Conditions under British and Native Rule: A Comparison of the Revenue Systems of British India and Rajputana." By MICHAEL FRANCIS O'DWYER, I.C.S., Settlement Commissioner, Alwar. Colonel GEORGE HERBERT TREVOR, C.S.I., will preside.

JUNE 1.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal. The EARL OF ELGIN AND KINCARDINE, K.G., G.C.S.I., G.C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

MAY 16.—"The Artistic Treatment of Picture Frames." By I. HUNTER DONALDSON.

MAY 30.—"The Revival of Tradesmen's Signs." By J. STARKIE GARDNER, F.G.S.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

PROF. HENRY R. PROCTER, F.I.C., "Leather Manufacture." Four Lectures.

LECTURE IV.—MAY 8.

Oil dressing—The chemistry of the process—Combinations of oil and mineral tanning—Vegetable tanning matters—Chemistry of the tannins—Practical methods—Combination of vegetable and mineral tanning—Currying—The chemistry of oils and fats used—Theory of the currying process.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 8... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Henry R. Procter, "Leather Manufacture." (Lecture IV.)
Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Medical, 11, Chandos-street, W., 8 p.m. Annual, General Meeting.

TUESDAY, MAY 9...Royal Institution, Albemarle-street W., 3 p.m. Prof. Silvanus P. Thompson, "Electric Eddy-Currents." (Lecture II.)
Medical and Chirurgical, 20, Hanover-square, 8½ p.m.
Photographic, 12, Hanover-square, W., 8 p.m. Mr. E. Sanger Shepherd, "The Photography of Colour."
Anthropological, 3, Hanover-square, W., 8½ p.m.
Colonial Inst., Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir John Robinson, "The Colonics and the Century."
Asiatic, 22, Albemarle-street, W. 3 p.m. Annual Meeting.

WEDNESDAY, MAY 10...SOCIETY OF ARTS, John-street, W.C., 8 p.m. Mr. George Bunyard, "Fruit Growing in Kent."
Geological, Burlington-house, W., 8 p.m.
Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.
United Service Institution, Whitehall, S.W., 3 p.m. Mr. Pulteney Bigelow, "The Yankee Soldier as I saw him at Tampa and Manilla during the late War."
Royal Society of Literature, 20, Hanover-square, W., 8½ p.m.

THURSDAY, MAY 11 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Michael Francis O'Dwyer, "Agrarian Conditions under British and Native Rule: A Comparison of the Revenue Systems of British India and Rajputana."
Society for the Encouragement of Fine Arts, 8 p.m. Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lewis F. Day, "Embroidery." (Lecture II.)
Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MAY 12 ..Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting, 9 p.m. Professor Thomas Preston, "Magnetic Perturbations of the Spectral Lines."
Astronomical, Burlington-house, W., 8 p.m.
Philological, University College, W.C., 8 p.m. Annual Meeting.
Physical, Chemical Society's Rooms, Burlington-house, 5 p.m.

SATURDAY, MAY 13...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. L. Brown, "To Iceland in Search of Health." (Lecture II.)

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FRIDAY, MAY 12, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, 20th June. The reception will commence at 9 p.m.

The following portions of the Museum will be open:—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery; on the First Floor—the East and West Corridors, and the Lecture Room.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These tickets will be shortly issued. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the *Conversazione*. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary) or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

CANTOR LECTURES.

On Monday evening, 8th instant, Professor Henry R. Procter, F.I.C., delivered the fourth and last lecture of his course on "Leather Manufacture."

A vote of thanks was passed to the lecturer.

The lectures will be published in the *Journal* during the summer recess.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 27, 1899; the Lord Chief Justice of England, G.C.M.G., in the chair.

The paper read was—

JUDICIAL REFORM IN EGYPT.

By Sir John Scott, K.C.M.G., D.C.L.,

Deputy Judge Advocate-General, and late Judicial Adviser to H.H. the Khedive.

"Inter arma silent leges" and the splendid military achievements of the Sudan have diverted the attention of the students of modern Egypt from the progress made in the administration of justice in the country. I am very glad, therefore, to have this opportunity of placing before the public a short account of what has been done, under English guidance, to ensure evenhanded justice between native and native on the banks of the Nile.

There are, as everyone is aware, various systems of justice in Egypt. The ordinary right of a State to impose upon all those who dwell within its limits the authority of its own laws, administered by its own Courts of Justice, does not yet prevail. Foreigners enjoy extra-territorial rights, and in criminal matters they are only amenable to their own Consulate and their own laws; whilst their civil disputes *inter se* or with a native are placed under the exclusive cognisance of the mixed tribunals. This privilege of extra-territoriality was created by the Capitulations which were granted in mediæval times, in order to induce foreigners to settle in the Ottoman dominions, and which are still in force. They had their justification, as far as Egypt was concerned, in the fact that until recently there was no such thing as native justice. But under the British *régime* there has gradually grown up a national system of justice which will soon enable the Egyptian authorities to say to Europe, "We can now give you justice in our own Courts, we ask that all who dwell in our country shall be amenable to the ordinary municipal tribunals and

law." This is not a change that can be made by a stroke of the pen. The consent of the European Powers would be necessary, as, even if the mixed tribunals were abandoned, they could claim to re-establish Consular Courts. Naturally such a right would not be abandoned save on the strongest guarantee that sound justice would be administered by the Egyptian Courts. Yet, speaking as a man who honestly cares for the country, and who, by long residence and constant desire to bring forward the Egyptian, might almost claim *droit de cité* as an Egyptian, I am absolutely convinced the native tribunals of Egypt must eventually be the only tribunals in the country.

It is of the progress of these native tribunals that I wish to speak to-night. I was specially charged, as legal adviser to the Khedive for eight years (1890-98), with their development, whilst as an Appeal Judge in the mixed tribunals from 1876 to 1882, I had considerable experience of the time when Egypt possessed no native Courts worthy of the name. In my account I may have to mention myself more than I like, but I wish to say at the outset that I never initiated any important reform in judicial organisation without having first explained and discussed it with the Khedive, the Minister of Justice, and the leading members of the Legislative Council, and without this co-operation I could not have succeeded. You may make a canal or a railway without the consent of a people, but you cannot make a system of justice.

But Egypt has many masters, and I have not yet mentioned the one on whom I most relied and who always did the best for the country. I mean Lord Cromer. As I said in my farewell speech to the Egyptian Judiciary :—" His lordship knows the country and its needs better than any other man in Egypt, and he waits patiently till the moment has come when the reform can be made, and once he is convinced your plan is not only sensible but opportune, you are sure of his support, and this support I always had."

One of the secrets of Lord Cromer's remarkable success as an administrator lies in his patience. Each of his great reforms has had to wait its turn. When rebellion was suppressed and order restored, finance came first. "Put money in thy purse" is an essential preliminary to all progress. As soon as a sound, financial system was established, he turned to the development of the sources of material wealth. He took public works in hand, and he never did a better stroke of business in all his busy life than when he persuaded the financial authorities of Egypt to place a million sterling at the disposal of Sir Colin Scott-Moncrieff for the barrage and general irrigation. It resulted in a glorious success. But meanwhile Lord Cromer let justice and education wait outside the door ; he had invited Sir Benson Maxwell at one time and Sir Raymond West at another to devise a plan of judicial organisation, and encouraged Nubar Pacha to form native courts. But the time had not yet come for his interference. However, in 1890, he wrote in his Annual General Report on Egypt, " above all the judicial and police systems require to be put on a sound footing." His Lordship, having thus decided that the time had come for judicial reform, did me the honour of asking me to leave my judicial work in India for a year, and to spend that year in Egypt, with the view of there studying native justice as it then was, and making a report as to the best mode of its reform. I was lent to Egypt by the Indian Government, and spent a year in visiting the tribunals, assisting at the hearings, talking with the judges, examining their records, and generally studying the actual system in its working all over the country, from Assouan to Alexandria.

Then I made my report. It was, undoubtedly, a gloomy document. I had found codes, good enough in themselves, but a large number of the judges, whose duty it was to interpret and apply the codes, were quite unfit for the work, whilst the Executive did not enforce the decisions with any regularity. The Judiciary themselves were timid as regards the executive authorities, the police were corrupt, and the mass of the people entirely refused to give any information as to the cause or the author of any crime in their district. There were only seven tribunals altogether in the country, yet the great majority of the civil cases was so small in the amount in dispute, and the people were so poor, that the injured party could not afford to go any distance to obtain justice. There was no system whatever for the appointment of judges. A certain number were excellent magistrates, but many had been named arbitrarily by the Government, some by favour, some because they were unfit for the office they previously held. The tribunals had been apparently labelled " Rubbish may be shot here." The Bar was even worse than the Bench. There were a good many decent judges ; there was hardly one capable advocate. I pointed out clearly all these defects, but I insisted that reform was wanted, not revolution. I have a

lawyer's dislike of radical remedies. They are very expensive, they disturb existing interests, and they upset the way of doing things to which the people have become accustomed. The native tribunals had been founded on the lines of the mixed tribunals, the French codes were the basis of their law, the people had to a certain extent got used to the French system, French was the foreign language then generally in use. As a judge of the mixed courts I had applied French law and procedure and had found they worked fairly well. With the exception of the Englishmen in the Court of Appeal and the English members of the Bar, there was hardly a person in the country who would have really welcomed at that time a complete change in favour of an English system of law. I, therefore, urged that better men were wanted, not new measures. As I said in one of my reports, *tant valent les juges tant valent les lois*. After much hot discussion my report was finally accepted as the basis of judicial reform, and I was persuaded to give up my Indian career for this new work in Egypt, not I confess without great hesitation, as two eminent Englishmen had preceded me without success.

Some cardinal changes were necessary as well as many minor ones. We began with what was essential—"Festina lente" was always my motto. A certain number of the judges were totally unfit for their posts, and they could not be allowed to continue. There had been no regular system of judicial nominations, and many members of the bench reminded one of Figaro's saying, "They wanted an arithmetician, and so they chose a dancing master." For example, a doorkeeper of a recent Prime Minister had suddenly become a Judge of the Court of Appeal, and I could cite other equally flagrant cases. However, I consulted with the authorities of the Ministry of Justice, and the best men of the judicial staff, and gradually, after careful sifting, we were able to put on the retired list the most unfit, the Financial Department providing them with pension according to their years of service. But no judge was retired until we had found a better man to put in his place. By the end of my first year of office, thirty-three new judges, bout 30 per cent. of the Judiciary, had been ntroduced in the place of the most incapable. We then made a strict rule that in the future a legal diploma was essential for judicial office. There was a school of law in Cairo, but it had been neglected to such an extent that it had not even a director. Fortunately a good many young Egyptians had recently obtained legal degrees in France and Italy, so that we had a certain choice—a somewhat youthful choice no doubt—ready to hand. We at once set to work to regenerate the Egyptian school of law. We were luckily able to induce a professor of law from one of the Universities of France to accept the direction and he turned out a great success. No man in Egypt has done better by his pupils, no man is more loved and respected by them than M. Testoud. In two years' time we had a good staff of teachers, French, Italian, and Egyptian, and 100 pupils all being trained for the legal profession. The period of training was fixed at four years with annual examinations. As I was President of the Board of Examiners, I am in a position to say that the pupils worked excellently, though perhaps their enthusiasm was not so much from love of the study of law, as from the desire to secure Government employment. Their main defect was one common in the East. They trusted too much to memory and did not think out sufficiently the codes and general principles of law for themselves. No pupil was admitted without a certificate that he had passed the secondary examination in the Government schools, so that they were sufficiently grounded in general knowledge.

Having laid down the condition that a legal diploma was necessary for judicial service, we next established a system of gradual promotion of the judges. My object was to found a real judiciary in the country. The successful candidates who had passed all examinations entered the service from the Law School, in the lowest judicial class, at a salary of about £100 a year, and if they merited promotion they slowly climbed up the judicial ladder until they reached the Court of Appeal with a salary of about £800 a year, whilst Europeans, who had to change country and climate, received £1,000 a year. The principle of irremovability of judges was established for the Court of Appeal, whilst the judges of First Instance had an almost equally certain tenure, as they could only be dismissed on proof of grave misconduct, established by a judicial inquiry conducted by the Court of Appeal. Of course, a good many of the originally incapable ones still remained, but they were now in the minority, whilst the whole Judiciary was undoubtedly leavened with a better spirit, and we continued very gradually to eliminate the most unfit by the inducement of pension, or the offer of other administrative work. The salaries may not seem in England to be sufficient, but they

are as high as those paid in Continental countries for judicial work. For instance, in Paris, the First President of the Court of Cassation receives only £1,200 a year. The other Presidents receive £800, and ordinary members £720. Appeal Judges receive £440 a year, Judges of First Instance £320, and Juges de Paix £120. In the provinces the salaries are less than they are in Paris. The salaries given are amply sufficient in Egypt for all the necessary requirements of life, and although a good salary does not make an honest official, it greatly lessens the temptations to dishonesty. A good salary, coupled with the certainty of tenure as long as they did their work well, made the post of judge the most popular function in the whole Egyptian administration. Certainty of tenure on condition of good service was such a novelty.

The difficulty of finding good men for the post of judge, and the gradual increase in the number of cases set down for hearing, set us to consider how we could diminish the number of judges required for the present work, so as to set free some of them for new work.

As an Englishman, I entertained strongly the opinion that the one-judge system in First Instance was the best. It concentrates responsibility, whereas three or five judges sitting together so divides responsibility that often the majority of the Court takes little interest in the business, and in practice everything is too much done by one man, whose individual action is saved from criticism by the presence of his colleagues. Of course, I am only speaking of cases in First Instance, but I felt that if I could improve the character and capacity of the First Instance judges, and teach them to face the responsibility of sitting alone, the quality of the work done would be much improved, and a certain number of judges would be free for new work. In appeal, especially in appeal on points of law, I hardly need add the authority of a plurality of judges is necessary both to satisfy the public and to ensure a right decision. I met with great opposition at first when I proposed the one-judge system. Those were days when anything English was eyed with suspicion. The Egyptians themselves did not dislike the idea, as the Mohammedan Judge, the Kadi, always sits alone; but legal training in Egypt is based on French lines, and, save in the most trivial matters, a Frenchman holds the plurality of judges essential to the proper administration of justice. But I fortunately found that the *Juge unique* system had been adopted in Algeria in the form of a *Juge sommaire avec compétence étendue*, and eventually, after much discussion and considerable delay, the Council of Ministers decided in my favour, and I carried a Bill which enabled a single judge to decide in First Instance all civil disputes where the value of the claim did not exceed £100, and all criminal cases where the maximum punishment that could be inflicted did not exceed two years' imprisonment. As an ancillary measure I carried a second Bill that established local Courts of Appeal of three judges, who heard, in Final Instance, all appeals from a single judge. And thus the Central Court of Appeal was left free to the due consideration of really important cases.

The introduction of the one-judge system at once placed at liberty a considerable number of judges. Up to that time there had only been in the country seven tribunals with a central Court of Appeal, which heard all appeals of every kind of importance. Petty appeals were now separated from important appeals, and we proceeded to distribute throughout the country, at centres most accessible to the people, single judges, who sat daily for the hearing of civil or criminal cases. The whole number of judges in the country was rather over a hundred; the number of the *Parquet*, which in English may be described as the Public Prosecutor's department, was somewhat over seventy. Very gradually—our progress being dependent on grants from the Treasury for the establishment of these new tribunals — we established 45 one-judge tribunals all over the country. We chose our judges partly from those whom the reform had set free and partly from the best men in the Public Prosecutor's department. As a further ancillary reform, I carried a measure which limited the right of appeal to cases where the amount in dispute was not less than £10. The result of these changes was that the peasant, desirous to recover a small debt, say of a hundred piastres, was no longer obliged to travel many miles and obtain the decision of three judges, which decision, even if favourable, was liable to an appeal to a court in Cairo composed of five judges. He can now go the town close by, an officer of the court on his statement draws his claim for him, it is served at once on his adversary, a day is fixed for the hearing, and as there are no arrears in any tribunal, he gets his decision on the appointed day. That decision can be executed by the summary court if

the sum awarded is under £10; if the sum awarded is over £10 there can be an appeal, but that appeal goes, not to Cairo, as of old, but to the nearest provincial capital. The execution of judgments, which used to be arbitrarily withheld, is now carried out by the administrative authorities as regularly as it is in England.

The introduction and great expansion of the one-judge system rendered necessary the establishment of some system of judicial superintendence. Justice as the sole basis of social relations was an absolute novelty, and the new judges, though full of zeal and good intentions, were without experience. It had been necessary to choose young men, because the older generation had been brought up under an arbitrary system. The older judges required, perhaps more than the young ones, constant supervision as regards both the amount and the quality of their work. But I came to the conclusion that whilst superintendence was essential, the *revision* of judicial work was to be deprecated and avoided. Yet the Egyptian public could hardly believe in the impartiality, and freedom from corruption, of a judge, especially if he sat alone, isolated from his colleagues and free from all control. I know it will be difficult to persuade an English audience that the superintendence of judicial work and the inspection of judges can possibly be good things. Still things that sound bad in theory are sometimes excellent in practice, and England, with its centuries of freedom and education, cannot be taken as a model for an ignorant country like Egypt, which had been oppressed by foreign masters for a period beyond the memory of man. At any rate, I had come from judicial work in India, and had myself taken part in a system of judicial superintendence that had produced admirable results. Only a couple of days before I left India, one of the best judges on the Bombay Bench, who had spent 30 years of his life in the Indian Civil Service, and present here to-day, assured me that the great success of the Judicial Department in India depended upon this superintendence of the subordinate judges. I bore this opinion in mind and determined to apply to Egypt the Indian plan, with such modifications as were necessary. I could not utilise the Supreme Court in Egypt. Its reputation was not sufficiently established to justify such an augmentation of its powers. Still less could I utilise the district judges. Yet I had to find men of such weight and authority for my committee of superintendence that their names would obtain universal respect. The office of Judicial Inspector existed in other parts of Turkey, but it was only a cloak to abuse, because the inspector was as corrupt as the judge. I had to find my men amongst the Europeans in the country. I decided on a committee of three, composed of the Judicial Adviser as President (myself at that time, now my successor), with the Standing Counsel to Government, an Italian, Signor Moriondo, who had held high judicial office in his own country, and the *Procureur-Général*, a Belgian, Monsieur de Grelle, who had also held high judicial office in his own country, as members. I thus secured a committee with European judicial rank, which would ensure respect and confidence. I did not confer on this committee the power possessed by a High Court in India. In India, a High Court can not only send for proceedings and require explanations of any subordinate judge, and inspect the conduct of business in any subordinate court, but it has also a power to revise judgments and to alter sentences. I determined, as I have already said, to stop at superintendence. Consequently the Committee of Judicial Control in Egypt has no power to vary any judgment or sentence. The *decisions* are absolutely free from any control, but the committee, through its inspectors, at first three in number and now six, examines the *work* of every tribunal. The inspectors come from the upper ranks of the judicial body, half English, half native. They make reports to the committee once or twice a week. Their reports are examined and discussed by the committee, and whenever any fault is *made clear*, the fault is communicated to the judge concerned, or if the matter is very important, notice is given by general circular to all the tribunals. In spite of much adverse outside criticism the plan has been received with cordiality, and every assistance has been given to it by all the judges throughout the country. The tribunals dread the reproaches of the committee, and the absence of any note or circular for any considerable period is considered by the judges a matter of congratulation. The necessity for fault-finding has diminished, but, I am bound to add, the day is still far distant when this superintendence can be entirely withdrawn. I must also say that it was never extended to the Supreme Court of Appeal, although it included the provincial Appeal Courts, whose appellant power was much more limited. Everything possible was done to strengthen the prestige and independ-

ence of the Supreme Court of Appeal as the highest judicial authority in Egypt. Before I leave the subject of judicial superintendence I should like to add the opinion about it expressed by Lord Cromer and my successor, Mr. McIlwraith, in Lord Cromer's recent report on Egypt. Lord Cromer says :—

"I have on several recent occasions alluded to the Committee of Judicial Control which was instituted by Sir John Scott, and which constitutes one of the most valuable of recent reforms in the judicial administration of this country. I can now quote Mr. McIlwraith's testimony on this point. 'The system,' he says, 'has been the subject of much hostile criticism in some quarters, but it is found to work well in practice and it has a marked educational influence on the native judiciary in stimulating their efforts generally, and preventing the recurrence of particular errors of law.'"

The establishment of a judicial system in a country which had not known independence or justice for many centuries could hardly be secured without the assistance of Europeans. Lord Dufferin, in his report on the future of Egypt, maintained that European aid in the administration of justice would be necessary in the proportion of one European to three natives. It was difficult to find the right men, at the rate of salary which Egypt could afford, and the advantage of Europeans all over the country, not knowing the people or their language, was very doubtful. We decided to concentrate European assistance in the Supreme Court of Appeal, and in the Courts of First Instance of Cairo and Alexandria. The Court of Appeal is now composed of 20 members, of whom 10 are European and 10 are Egyptian lawyers. Of the ten Europeans, nine are English; one is a Belgian, and it is understood that when he retires his successor will be English. There are two Europeans in the First Instance Tribunal at Cairo and one at Alexandria. The rest of the judges at the provincial capitals and at the 45 judicial centres are all Egyptian. The majority are Mohammedans, but a due proportion of Christians, whether Koptic or Syrian, also hold judicial office.

One great obstacle to the increase of business in the native tribunals was their expense; the fees exacted were exorbitant, and as most of the civil claims were of very small amount, the people were deterred from coming to court. Several experiments in the way of reduction were made, without much success, as a general diminution of costs was not favoured by the Treasury on account of the risk of loss of revenue. But eventually the financial authorities withdrew their opposition, with a result most satisfactory to themselves as well as to the country, and consented to a very great diminution of legal fees; which resulted in such an increase of legal business that the aggregate receipts were more than they were before. It is satisfactory to be able to state that the receipts in 1891 were £78,000, with a very high tariff, and in 1899 they reached £115,000, with a very low tariff, whilst the number of civil cases heard rose from 16,800 in 1891 to 69,400 in 1898, of which 68,445 are cases decided by a single judge.

It is astonishing how rapidly a judicial *esprit de corps* has sprung up in the country. The Judiciary have now become an important body in the State, and are no longer neglected outsiders in the administration, who could be named and dismissed in a day, who received orders from the powers that be, and carried them out as if it was part of their duty. They are men of legal education possessing legal degrees. They have their proper place and rank in the Government service and at the State levées, and they wear judicial costume when in discharge of judicial functions. The Khedive, in his frequent journeys through the country, never fails to see the judges and tribunals. I must not take up time by many instances of judicial independence, but I will mention three. I remember three years ago one of the richest and most influential people in Lower Egypt was charged with forgery. He moved heaven and earth to save himself from punishment, and was absolutely astounded when the court below found him guilty, and the Court of Appeal confirmed the conviction. In the same year, the son of one of the wealthiest proprietors in Egypt had chosen to amuse himself by organising a band of brigands, who attacked outlying villages and robbed and killed as they used to do in the good old-fashioned times. He was just as much astonished as my friend the forger when he found himself doing a long period of penal servitude. Only last year, a Prince, cousin of the Khedive, great grandson of the founder of the Khedivial family, walked into the principal club of Cairo with a loaded revolver and fired upon and wounded another Prince of the Vice-regal family with whom he had a quarrel. He, too, like the forger and the brigand, is suffering in a convict prison the effect of the new reign of equal law.

There was, however, a time of transition, when all arbitrary action was suddenly abandoned

in favour of the impersonal action of law, and it seemed as if the country was not ready for the change. The older fashioned inhabitant shook his head and said it would not do. "They want the hand of a master and the courbash is better than your codes" said one of the older Pashas to me. There was no doubt a risk in the experiment. In the old days guilty men may have escaped, innocent men may have suffered, but order was maintained. The following story will tell how things used to be done. Two travellers went to see Kalioub, a town a few miles from Cairo. They called on the Mamour (Governor) and talked to him of his province. Whilst they were there a report came of a murder, and the police brought in four men as the accused. The Mamour sent the men to his Secretary to be examined. The Secretary returned in a quarter of an hour and said that from the confusion of their answers he was convinced of their guilt. The Mamour then said "Good, telegraph to Cairo and ask what shall be done." Answer came back "Since the guilt is evident let them be hanged." And they were hanged next day. Whole villages were uprooted and the inhabitants deported to the South because murderers were not produced. Nubar Pasha once said that a woman could walk from Alexandria to Assouan with her gold bangles on her arms, without the slightest risk of robbery. When the rule of law was declared, this security for a time disappeared. Bands of brigands were formed, and whole districts were considered unsafe. The police connived at crime; the peasants refused, from fear of revenge, to denounce any offender whether great or small. The desire of revenge was not satisfied by the punishment of the offender by the law. I was present myself at the trial of an old man who had killed his neighbour for removing the landmark which divided their property. "Why," asked the presiding Judge, "did you do this, when the law had already punished your neighbour?" "Because," the old man replied, "I was bound to have my own revenge."

But this transitional period—which was at its worst when I was appointed—has now yielded to the reign of law.

There is now not a single band of brigands left in the country and there are as few crimes in Egypt as there are in England in proportion to the population. Not very long ago I had an interview, in a convict prison, with the most noted of all the brigand chiefs, a man named Ahmed Selim. He ought to have been hanged, for he had killed a great many people, but he had only been given penal servitude for life. He talked freely, and bitterly complained that the peasants had betrayed him to the police, which, he said, would never have happened in the old days. And he added: "There is no trade of robbery now, the peasants only rob and then go to work, and then they work, and then they go to rob. But the brigand who was only a brigand has gone."

I have already stated that the *Parquet*, composed of the *Procureur-Général* and his deputies, corresponds to the office of the Public Prosecutor in England, but at the outset of our reforms this description was not formerly quite accurate. The *Procureur-Général* was something between a counsel and a judge; he could even ask the court to acquit the prisoner, and really played the part of an extra judge, who was not only charged with the prosecution, but held the scales of justice in his hands. This system may work well enough in France or Italy, from whence it was borrowed, but it led to many acquittals in Egypt. A weak court, or a lazy court, really followed the lead of the *Procureur*, and did not take the trouble to examine the facts and decide for itself. After the usual amount of discussion, I obtained a change in the system, and the *Parquet* is now confined to the direction of the police in the investigation of crime, and to the development of the charges as prosecuting counsel when the case has reached the stage of final trial. In order to ensure the accomplishment of this reform an Englishman was appointed as *Procureur-Général*.

Another change was made in favour of the speedy and certain repression of crime. The French system of the *Juge d'Instruction* had been at first adopted in its fulness. Every crime, however unimportant, had to go through the stage of judicial investigation before the *Juge d'Instruction*. The case was prepared by the police and *Parquet*, but however complete it appeared, it had to be examined, and all the witnesses heard, by the *Juge d'Instruction*, who alone could send it to trial. This caused not only great delay, but was so inconvenient to witnesses, that those who could give evidence always maintained they knew nothing, and the crime went without punishment for want of proof. We determined that only cases of great importance, requiring very delicate management in their preparation, should go through the preliminary of the *Juge d'Instruction*. The decision as to what cases should still be presented to him was entrusted

to the *Parquet*. As a matter of fact the *Juge d'Instruction* is scarcely ever called upon; the cases are presented direct to the court, with the result of greater promptitude, increased ease of obtaining evidence, and a more certain punishment of crime.

Until five years ago it was almost impossible to apply capital punishment as the extreme penalty of the law in the case of crimes however atrocious. Capital punishment was admitted as one of the penalties to be applied under the criminal code, but whilst this provision was adopted from the French law, another provision was introduced by Mohammedan professors which rendered the power almost illusory.

Article 32 of the Egyptian Penal Code ran as follows:—"The death penalty can only be pronounced in the case of a confession, or if at least two witnesses give evidence that they saw the accused commit the crime."

This article led to two unfortunate results. The police from excess of zeal were either induced to extract confessions, true or false, by violence, or they suborned witnesses to swear falsely as to what they had seen. Under the new *régime* these methods were strictly forbidden, and consequently, as murderers do not as a rule commit the crime in the presence of others, or confess their own guilt, capital punishment was hardly ever inflicted, even in the most atrocious cases of brutal murder. It was proposed to suppress Article 32, and to prove the crime of murder, equally with other crimes, by the ordinary laws of evidence. But the discussion lasted over a year, and the Mohammedan authorities finally yielded on its being shown that the penal code, applied throughout the Ottoman Empire on the authority of the Sultan, did not contain this exceptional provision. I hardly need add that capital punishment is still very rarely used, but in a country new to justice, where order and security are still imperfect, terrible cases of brutality sometimes occur which call for the punishment of death.

I will not trouble my audience with a detailed account of all the smaller changes we effected. There are one or two, however, I should like to mention. False testimony was terribly prevalent in the Egyptian tribunals. As in India, a judge's greatest difficulty was to find the truth in a heap of lies. Prosecutions for perjury were long and intricate. Some speedier remedy was required. We decided to empower the judge to treat flagrant perjury *séance tenante* as a contempt of court punishable by a very limited period of imprisonment. The power has been much used, and already the lying has considerably diminished.

Before 1891 there was not a single Tribunal of First Instance which possessed a law library. The judges had their codes, but that was all. Yet these codes were taken almost entirely from the legal system in use in France, and each French Code has been explained at length in excellent commentaries compiled by eminent French lawyers. We selected those commentaries on the French Codes which have the greatest authority in France, and sent a complete collection of them to every tribunal, great and small, throughout the country. I may add that all the judges read and talk French as well as Arabic. French and Arabic were the languages used on an equal footing in the School of Law. Last year, I am glad to say, the Educational Department was enabled to add English to the languages used in the teaching of law.

Another change of some importance was made. Until a few years ago, no authorised reports were published of the decisions of the native courts. Yet publicity at a certain stage of judicial institutions is not only a check on judicial carelessness, but acts also as a stimulant to the production of sound and well-considered judgments. An able lawyer, who was one of the editors of the reports of the mixed courts, undertook to publish monthly the reports of the decisions of the native courts, and the result has been excellent.

There was no useful labour in the prisons. We carried a Bill empowering the present authorities to improve such labour as was suitable to the prisoner, and now there are many prison industries which not only bring in money, but enable the man to earn an honest livelihood when he is set free. The measure was much opposed. I remember when I attended the Legislative Council to support it, one of the older fashioned rose and asked if a Pasha was sent to prison would he have to work? I replied that I trusted the Pashas would never commit crimes, but if they did and were condemned they would have to work like anybody else. The Bill was passed by a very narrow majority. It was followed by a second measure, which enables the authorities to utilise prisoners for public works outside the prisons.

The prisons were defective in another and even more serious way. There was no distinction made between first offenders and hardened criminals, young boys and old men:

all were herded together. Prisoners are now classified and segregated, and juvenile offenders are sent to an excellent reformatory, where they are taught a trade and to read and write. Until four years ago there was no record kept of old offenders. Previous convictions are now recorded and proved in Court, whilst the Anthropometric system is introduced in the prisons.

There is one more point. The native courts have not at present any jurisdiction in questions of personal status—questions of marriage, alimony, divorce, or succession — which are decided according to the *cheria* or sacred law by the Kadis, under the direction of the Grand Kadi. All students of the Koran know that the amount of jurisprudence to be found there is really small. Mr. Stanley Lane Poole tells us that chapters II, IV, and V contain all the law of the Koran, but even in those chapters ritual and ceremonial and morality are strangely mixed up with civil and criminal law. However, round the law of the Koran, there has grown up a quantity of juridical literature, Arabic and Turkish, which is now given authority, and the Kadi courts claim the exclusive right to administer it so far as it relates to personal status. These Kadi courts had become subject to such abuse that they were a crying scandal. The country was hardly prepared for their fusion in the native tribunals. We, therefore, proposed to impose upon them a simple system of procedure, that is of first-instance tribunals with an appeal court, and to give the winning party the right of execution of judgments concerning inheritance and succession. Our proposal was accepted. A system of inspection, analogous to that practised in the native courts, was also created, and the control of the property of orphan minors was placed in the hands of the native Court of Appeal. More important still was a proposal to fuse the Grand Kadi's Court of Appeal with the Mohammedan members of the native Court of Appeal. This proposal, which I left in the hands of Mr. McIlwraith, my able successor, was accepted, thanks to to his advocacy, but it has not yet become law on account of the opposition of the Legislative Council for the astounding reason that the reform is contrary to the Mohammedan religion. This stubborn resistance to reform may lead to the fusion of the religious with the ordinary tribunals. Such a fusion would be most welcome in the country.

It would be the forerunner of a still more important amalgamation. It was the ambition of Nubar Pasha, it was my ambition, it was the ambition of every lover of Egypt, to steadily improve the Native Courts, until they could fairly claim to administer every form of justice to every class of suitor, and to every nationality. Lord Dufferin said in his famous report of 1883 on Egypt:—"It is the natural and legitimate ambition of the Egyptian Government eventually to supersede the international tribunals by its own tribunals." It will take time. They are not yet ready. But I hope you agree with me that they are on the way.

Now I have told my story, I trust withont wearying my audience. I propose, my Lord, to conclude my lecture with the final words I spoke at the leave-taking with my friends in Egypt last May:—

"I came to Egypt first in 1872 as a perfect stranger. I was welcomed on all sides as a friend, and from that day to this I have received nothing but kindness from all who dwell in Egypt. It is a satisfaction for me to feel that I have done some little good in the country which has treated me so kindly, and which I love so well. Sir Edward Malet, in a farewell speech in 1883, declared his great wish for the country was 'Justice, Justice, Justice.' I am proud to think I have had a part in the realisation of this grand desire. I found in 1890 a set of native tribunals that were struggling for existence. I leave behind me a set of national tribunals which will, I trust, be the backbone of the country for all time."

DISCUSSION.

Sir RAYMOND WEST, K.C.I.E., said this subject was one of very high importance to an English audience, because the credit of our country was most deeply involved in the success or ill-success which attended the late measures in Egypt; and in the basis of every reform there must be that moral element which was involved in the administration and appreciation of justice. He had no claim to speak on this occasion, except that having had a little experience in Egypt himself, as the predecessor of Sir John Scott, in the kind of work which he had to some extent carried out with remarkable success, although there was still something to be done, he had an opportunity of seeing what the necessities of the country were, and the means at our disposal of meeting them. Nothing struck even a casual visitor to Egypt more than the necessity of continued pressure on the population of the weight of intelligence and high principle borrowed from Europe, and that ought to be infused, first, into the indigenous administrative body, and, secondly—and this was even more important,—through the whole judicial system. That struck him very much when he went to give some assistance in the organisation of the

courts in 1885 and 1886. One of the first points which he was led to dwell upon in his conversations with Nubar Pasha was the very low position held by the native tribunals, which they must continue to hold as long as there was by their side another set of tribunals manned practically by delegates from the European Powers, representing their intelligence, but also their jealousies, and in many instances nominated practically not so much to administer justice to people in Egypt as to maintain the dignity and the interests of the country that sent them. Over and over again he dwelt upon the necessity of getting rid of this system, and though Egypt itself could not get rid of it, they would, at any rate, pave the way for it by raising by degrees the status of the judges of the indigenous tribunals. One means he proposed was that there should be an interchange of *personnel* between the two; that wherever it was possible to give a member of the mixed tribunals promotion, by putting him into one of the indigenous tribunals, the opportunity should be taken of doing so, and, on the other hand, when a man had distinguished himself in the native tribunals, an opportunity should be taken, if possible, of putting him into the mixed tribunals, and he hoped in that way there would be a gradual elevation, not only of the intelligence, but of the dignity and self-respect of the members of the native tribunals. He hoped that supplement to the general scheme advocated by Sir John Scott would receive his support so far as it might be found necessary in the somewhat changed circumstances now existing. With regard to the *personnel* of the courts, he might mention one matter which came under his own observation. When, as *Procureur-Général,* he took a part in conferences of the chief Court of Appeal of Cairo, he found that one of his colleagues had graduated in the position of station master. This judge had been able to show civilities to certain official persons, and as no more suitable way of rewarding him could be found he was put into the chief Court of Appeal. The *personnel* being such as it was, the necessity of supervision would naturally occur to any man of Indian experience, because in India it had been found very often that personal supervision of the courts, and an occasional visit by the superior judge or officer, and turning up of the records and discovery of negligences and ignorances here and there, had a most beneficial effect on the subordinate judges. This was a point upon which he often dwelt in his conversations with Nubar Pasha, and he had touched upon it at some length in one of his reports. He confessed there was a point in the system of revision, which was now apparently established in Egypt, which seemed to him to present difficulties. The working of a court and the way in which a judge carried out his duties were connected at every point with the administration of the law, and it always appeared to him that the right system of superintendence was that adopted in India, namely, that the inspector who went round and discovered negligence or errors in the work of the court should report to the chief judicial authority, not to a branch of the Executive. Now under the existing system in Egypt it seemed to him that this difficulty would be pretty sure to arise: that reports would be made by inspectors to the committee of inspection, and the committee would issue directions thereon or make remarks on the business as done by the judges in the local courts which might not agree, but might clash altogether with the views taken on some points by the High Court; and that would be a most awkward result. He thought it would be found necessary in Egypt, if there were a system of mixed inspection, that the results should be sent up to the chief court, and be dealt with there by a committee, by individual judges, or, in important cases, by the whole court. The incompetence of the judges was now to some extent corrected by exacting from candidates for judicial office a diploma. In his time he did not feel competent to go far in that direction; but he had headed a deputation from the Bar in Cairo to Nubar Pasha, asking him to accept a scheme of organisation of the Bar, and in connection with that it was proposed that a school of law should be established. It appeared to him, however, that even now the school of law was not founded altogether on a sound basis. It was a school headed by a French lawyer and teaching French law, but in Egypt there was a Mohammedan population, and this population would thus be subjected to French law to be administered under British supervision. Nine out of ten European members of the chief court were English, but it was impossible that this supervision by Englishmen and the predominance of English influence should be dispensed with. He, therefore, thought this school of law would want a considerable amount of revision and amendment before it could be considered satisfactory. A law school in Egypt ought to take into account the fact that the mass of the people were Mohammedans who could not regard with reverence any law not founded upon or deduced from the principles of the Koran. It was quite possible at the present day, when the great intellectual movement of the century had certainly reached the younger classes of educated Mohammedans, to found a school which would create a rejuvenesence of Mohammedan law, which it must be remembered was for many centuries considerably in advance of the Christian law which prevailed in Europe from the 7th to the 16th or 17th centuries There had been such diffusion of practical views, as well as of moral ideas, amongst educated Mohammedans, that if the idea were taken up, and a Mohammedan school of law established on enlightened and liberal principles, he believed it would attain a brilliant success, and would be quite capable, under the hands of a man of genius, of proving that the Mohammedan law was readily adaptable to all the necessities of modern progress.

Mr. JOHN MACDONELL, C.B., LL.D., said he

could not speak with any particular knowledge of Egypt, but he was glad of the opportunity of paying a mark of respect to his esteemed friend, Sir John Scott, and of pointing out that the story he had told was a most remarkable one—a story of work crowded into eight years, which might have been spread with credit over nearly a century. They had heard a great deal of the marvellous military and engineering achievements in Egypt; but, if he were not mistaken, when recent events had receded into the distance and assumed their proper proportions, the narrative laid before them that day of judicial reforms would be as durable as that of any of those achievements to which he had referred. If this work had been accomplished, not in the reign of Victoria, but in some of the old dynasties, his esteemed friend would not perhaps have had a pyramid, but certainly an obelisk, or a monolith, or something enduring, would have been erected to him. This work was to him of all the greater interest, because it was part of a movement which was going on pretty nearly all over the world; wherever Western civilisation came into contact with barbarous, semi-civilised, or retrograde communities, there went on a struggle similar to that which had been described; the conflict of Western ideas of justice and Western modes of procedure with Eastern. Particularly was there a conflict between the Western notion of purity of justice when it came into contact with the crude notions which prevailed in other countries. At all these points, with few exceptions, foreigners were more conspicuous than Englishmen. In the great work going on in Japan, Frenchmen were conspicuous; in similar work in Siam Frenchmen were now conspicuous; but at all events, in Egypt where a work comparable to any of those accomplished elsewhere had been carried out, it was satisfactory to know that Sir John Scott had been the agent. One of the facts to his credit was, that whereas in all those countries, as a rule, the Frenchman, or the German, in charge of the work had taken care to apply his own ideas and the system to which he had been accustomed, Sir John Scott had the wisdom not to import blindly into Egypt English ideas, but had taken as the basis that which he found there and which was in many ways unsatisfactory—a French system of law and procedure—and had made the best of it. Possibly some hints might be derived from his work, which might be useful even in England. He noticed an observation to the effect that in its desire to accomplish certain reforms, the Treasury abated certain fees, and he wondered whether that had hitherto been characteristic of the Treasury of any country except that of Egypt. He would conclude by expressing as strongly as he could the sense of indebtedness they must all feel to Sir John Scott.

Mr. H. M. BIRDWOOD, C.S.I., LL.D., said that Sir John Scott, at the close of his most excellent paper, had, with characteristic modesty, expressed the hope that he had not wearied his audience. He would venture to assure Sir John that, far from wearying that assembly, he had successfully sustained the interest of his narrative to the very end, and, by his sketch—which was all too brief—of the details of his work in Egypt, had but whetted the appetite of all present for further information regarding the important measures of reform which he had introduced during the past eight years. To Anglo-Indians (such as were some of those there present), who had been concerned in the administration of justice in territories still to a great extent under tutelage, his narrative was indeed of absorbing interest. He (Mr. Birdwood) well remembered the conversation which Sir John Scott had referred to in far too partial terms. It was on the eve of his departure from Bombay to Egypt; and as he (Mr. Birdwood) described to him some of the salient features of the judicial system which had been adopted in the rural districts subject to the jurisdiction of the Bombay High Court, he was greatly impressed by Sir John's eager determination to secure for the people of Egypt some of those advantages which had been secured for the people of Western India by the establishment in most districts of civil and criminal courts within easy distance from the homes of the people—if not exactly at their own doors, in every town and village, yet not very far from the principal centres of population—and by the due and regular administration of justice in those courts. Sir John Scott was weak from illness at the time, and his strength of purpose, in depressing circumstances, in a strange land—if any land could be strange to one of his name—was a clear manifestation of the *perfervidum ingenium Scotorum*, by which he had never ceased to be inspired, even to the present day. He (Mr. Birdwood) would not attempt to describe in detail the peculiar merits of the Indian system. Still there were one or two matters to which he wished to refer, as they had a distinct bearing on the subject of Sir John's paper. And, first, he wished to bear his testimony to the vast improvement which had taken place in the *personnel* of the judicial administration during the past forty years. He would speak only of matters within his own knowledge. He could not indeed recall a time when the administration of justice in the Bombay Presidency was in so deplorable a condition as presented itself to Sir Raymond West and Sir John Scott in the early years of their Egyptian experience. Still, he remembered a time when it was far from satisfactory. But there had been a steady improvement everywhere, which had been the result of much careful consideration of the requirements of the people and of an earnest and continued effort to raise the qualifications and the whole tone of the judiciary. He was referring mainly to the large body of native judges of the subordinate courts, by whom the great mass of original litigation throughout the length and breadth of the country was dealt with in the first instance. No officer could now be appointed a subordinate judge unless he had either practised for five years as an advocate of a High Court in India

or a pleader of the High Court of Bombay or had passed a sufficiently severe examination to test his knowledge of law—either the examination qualifying for the degree of "LL.B." in the Bombay University or an equivalent examination prescribed by the High Court—and had, in addition to such test, practised, in accordance with a recommendation first made by Sir R. West, for a certain period in the civil courts or held certain offices therein, so as to become thoroughly conversant with legal business. Salaries had also been provided by the Government on a liberal scale, so as to attract candidates possessing the requisite qualifications; and promotion to higher grades of salary or jurisdiction was regulated, not merely by seniority, but depended also on the efficient discharge of duty. The records of cases heard by the subordinate judges came under the notice of the superior courts, not only upon the hearing of appeals, but could also be inspected by the judges of these courts, not with a view to any judicial interference, but in the exercise of a power of superintendence, recognised by law, with a view to the correction of faulty procedure and the prevention of any practice injurious to litigants or witnesses, and the more certain attainment generally of the objects for which courts exist. To this last duty special importance had always been attached by the High Court; for not only are there many matters connected with the disposal of judicial business which cannot well be considered at the hearing of an appeal against a decree or order, or an application for the revision of a decree; but the sub-judges are often at distant stations, isolated from any wide intellectual or professional society, and they welcome the periodical visits of the district judge or an occasional visit by a High Court judge, as furnishing an opportunity for discussing a hundred and one difficulties encountered in the daily practice and procedure of the courts. And, lastly, the High Court had used every effort, and with remarkable success, to raise the qualifications of the members of the legal profession practising as pleaders on the appellate side of the High Court and in the district and subordinate courts. The results of such a system, so patiently and thoughtfully worked out, had been most encouraging. The subordinate judges are, as a rule, well educated men of high character, who command the confidence of the people, and in the ranks of the indigenous judiciary and of the pleaders the Government can confidently seek for qualified candidates whenever the occasion arises to appoint a native of India to a seat on the bench of the High Court. As a matter of fact, there had been a succession of Indian judges of the Bombay High Court who had filled the position with eminent distinction. Sir John Scott had adopted methods in Egypt not very dissimilar from those in force in the Bombay Presidency. Judicial salaries had been made sufficiently liberal to attract the best talent available to the courts of first instance. Trained judges had replaced the incompetent judges of former days. The number of courts had been increased, so that people had no longer to travel long distances to obtain justice. The administration of justice had been made as speedy and as little burdensome to litigants as possible. Sir John Scott had, moreover, proceeded with caution, correcting palpable abuses, which had long been unchecked, and improving the available machinery as best he could. That was the surest way to carry the people with him. Reforms so effected were likely to last. One of the methods employed was an adaptation, though in a modified form, of the system of superintendence which had proved so useful in India. It was most satisfactory to Indian judges to hear of the great success which had so far attended Sir John Scott's efforts, and the only further comment he wished to offer was that nothing had been said as to the improvement of the local Bar in Egypt, but certainly that could not be a matter which had been lost sight of. And, after all, the reformed judicial administration in Egypt was still in the days of its early infancy. Patient continuance in the good work which had been begun would bring incalculable benefit to the people. Sir John Scott was to be heartily congratulated, not only for the admirable address to which they had just listened, but still more on the great work of which he had laid the foundations so well and truly.

The Right Hon. JAMES BRYCE, M.P., D.C.L., said he had enjoyed the friendship of Sir John Scott for more than thirty years, and he had also been in Egypt twelve years ago, shortly before Sir John commenced the operations which had been described, and which had conferred such inestimable benefits on Egypt. He remembered asking about the condition of the local judges and tribunals when he was in Egypt in 1887, and the account he received was perhaps even then a trifle better than would have been given in most parts of the East; but still it was to the effect that there were extremely few judges amongst the natives who could be trusted to give an honest decision, and that the measure of intelligence and knowledge was comparatively low. Any one who had travelled in the East knew it was a matter of course, except in those parts where, as in British India, a Western Government had come in, that the judge should be corrupt. Nothing else was expected from him. He would be regarded as stupidly neglecting his opportunities if he did not plunder suitors whenever the chance came. Therefore, the difficulties which a judicial reformer had to encounter in an oriental country were immeasurably greater than any one could realise from a knowledge only of Western Europe. The old habits of ages had to be broken down, and the very idea of judicial purity was so strange that it took some time to create the public opinion which was needed to support the efforts of the reformer. Egypt had had as melancholy an experience of foreign tyranny and misgovernment as any other part of the

East. Sir John Scott had said truly that justice was the first great need of such a society, and that no country had had greater ill luck than Egypt, because no country had had such uniformly detestable administration ever since the Mohammedan conquest in the seventh century of our era, with the solitary exception of the reign of the Sultan Saladin, during which time there was a vigorous and effective execution of the law, owing to the initiative of that great sovereign, which made his reign long remembered as a kind of golden age in Egypt. After those many centuries, at last the hand of the West had appeared, and a work had been done there of which they might be justly proud, and no one had borne a worthier part in the reform effected in Egypt by Great Britain than Sir John Scott. He could say, not indeed from direct personal knowledge, but from what he had heard from many well-informed people who had lived in Egypt during the time, that it would have been impossible to effect those reforms but for the unfailing tact, judgment, courtesy, moderation, and sympathy (as far as possible) with native ideas which Sir John Scott always showed. The improvement effected was enormous, yet he was afraid that even such work as Sir John Scott had done could not be considered to be so firmly rooted that if the protecting hand of Britain was withdrawn it would be certain to survive. He would not enter on the interesting question raised by Sir Raymond West, whether there might not be an independent revival of Mohammedan law, and a prospect of developing it into a system fit for a civilised country; but he should have thought that, although that might be interesting as a legal experiment, particularly to students of legal history, it might have its political dangers, and he should feel serious doubts as to its expediency.

The CHAIRMAN said he had now the honour of proposing a vote of thanks to Sir John Scott for his interesting address. He ought at an earlier stage to have called attention to a letter received from Lord Dufferin, who wrote expressing his great regret at not being able to attend on that occasion, and he added that "Sir John Scott has done a great work in Egypt, and we were most fortunate in securing his services for that country." Letters of a similarly appreciative kind had been received from the Lord Chancellor, Lord Rosebery, Lord Kimberley, Lord Roberts, and Sir Edward Grey. No one who had listened to the very simple and modestly told story of the work of Sir John Scott could have any doubts that these compliments were, in their highest and best sense, deserved. He confessed it had been a peculiar pleasure to him to have been able to preside there, because, like his friend Mr. Bryce, he was a friend of very old standing with Sir John Scott. He took, like all other members of the Northern Circuit —of which Sir John was one—an honest and just pride in the fact that one of its members had achieved for himself so distinguished a career, and had accomplished such solid work for his country. He recollected Sir John Scott when he thought him a man not likely to live long on the face of the earth, for when he was his colleague on the Northern Circuit he was in the most indifferent health; but at the same time he was always genial, sympathetic, determined, and courteous, as he was now, but he confessed he did not look forward with much hope to a prolonged professional life for him. He could only say it was one of the highest testimonials he had come across to the efficacy of hard work in promoting health, and to the salubrity of the Indian and Egyptian climates. It was a very remarkable story, a great work accomplished in something like seven years, and one could not but reflect that Sir John Scott must have had certain advantages in that. For instance, he had not the slow and cumbrous legislative machine that we had to deal with in this country. He was able to get his Bills without blocking through the legislative body, and without much difficulty, and he had the advantage undoubtedly, which he had recognised in his paper, of the strong moral and political support of, amongst others, Lord Cromer during the whole period. The change had certainly been very great. Sir John Scott arrived in Egypt to find a judiciary weak, unlearned, and corrupt, and he had left a judiciary with every hope that in time it would cultivate and acquire a sense of responsibility and self-respect as high as was to be found in the judicial systems of the West. He found a Bar marked by the same failings and shortcomings, and he had improved all these things. He found also that ordinary security for life and property were wanting, that crime went unpunished, and under the new and better system crime was now visited by adequate punishment, and the per-centage of crime was not as great in proportion to the population as in many of the communities of the boasted Western civilisation. One thing, however, struck him (Lord Russell) during the address, and that was that the great factor in such improved conditions had been British influence in Egypt. No one could doubt that this empire had made great sacrifices to help Egypt, and yet it was certainly a significant and a regrettable circumstance that the English tongue was not an instrument of knowledge or used in the courts of the country. Why was it? Why was there no immediate hope that that language and the influence of English thought should speedily become more general than it was now? When Sir John Scott cast about for the material with which to create the new judiciary, he had to rely on students who had got their education and their legal degrees, some in Italy, and some in France, but none in England. He wanted to know why? Was it not largely due to the fact that here in London, in their system of legal education, they did not recognise the great responsibilities they owed, and did not in their legal teaching offer the advantages which they ought to offer to attract from

all the English-speaking communities on the face of the earth, and where English influences prevailed, attractions which would induce students, including even those of foreign birth, to come to our schools? It was a positive disgrace that at this moment they did not offer any assistance in the teaching of the law which they had to practise abroad to any of the students that might come either from the Colonial dependencies, our spheres of influence, or even from such a country as India. He was aware that in the Universities there were students prepared for the Civil Service in India, and important work in that direction was being done; in Cambridge very largely by the efforts of Sir Raymond West; but in London—the great heart and centre of things, the seat of government, where the pulse of power beat most strongly, and from which radiated over the world in greatest measure the influence of the people of these islands—there was no provision of this kind, not even the very slightest. He thought this was a matter which required to be looked into, and he hoped they would find very soon that in the school of law which had been founded by Sir John Scott they might have the English language, which had been recently introduced, largely used, and competent English professors spreading ideas of English law, and with that ideas of English policy, and, therefore, of English influence. In conclusion, he might say that in the vote of thanks to Sir John Scott they were not thanking him merely for the literary merit and charm of his address, but still more for the great work which it recorded.

Professor A. V. DICEY, in seconding the vote of thanks, said that, like the Lord Chief Justice, he could carry back his memory of Sir John Scott for a great many more years than he liked to think of. He should like to give expression to what they all felt, that the work Sir J. Scott had done in Egypt was greatly owing to his extraordinary powers of sympathy, which were well-known on his old circuit. That was one of those gifts which was not perhaps quite so prominent in the Anglo-Saxon as some other virtues, but it was a gift which qualified the possessor more than anything else for administration in the East. Whenever he saw a young man, and he saw a great many, going out to govern India, he always hoped, and, in many cases, found that they were not only capable men but that they were sympathetic—that they would not go out with anything like dislike or contempt for men of one colour or another. He had never known a man who had so many English virtues of the highest kind, combining them with such sympathy, such tender sympathy, with the cause of the Egyptians themselves; for, after all, every man felt that the moral justification of England's presence in Egypt was that Englishmen were there, and ought to be there, for the benefit of Egypt, and not merely for that of England. Sir John Scott had represented this feeling better than any other man who could have been sent to administer justice to Egyptians; and it was for that reason he joined with the greatest cordiality in seconding this vote of thanks.

The vote of thanks having been carried unanimously,

Sir JOHN SCOTT briefly responded.

Lord SHAND then proposed a vote of thanks to his noble and learned friend, the Lord Chief Justice, for presiding. He said he came there quite ignorant and inexperienced with regard to Egyptian matters, but anxious to learn, and he had learnt a great deal. It was certainly amazing that in so short a space of time Sir John Scott had been able to bring about such a radical and complete reform, for which Egyptians ought to be exceedingly thankful to him. He had heard for the first time of the system of inspection of judges. He could only feel thankful that there was nothing of the kind in existence when he was a judge of First Instance. With regard to his noble friend in the chair, he had been much struck with the many sidedness of Lord Russell's character, which had been exhibited within a very short period. There seemed to be no matter of interest in which he was not prepared readily to take part. He had recently delivered an important address to the Chambers of Commerce with regard to a subject of great interest to the whole community, upon which he had introduced a Bill in the House of Lords. Again, only the other day, he was presiding at one of the most important of charitable institutions of this country, that which took up discharged prisoners, who were thrown on the world with nothing to look forward to but a recurrence of crime unless a kindly hand were extended to them. And again at Gray's Inn, within two or three nights ago, they found him helping the students by describing the art of pleading, and himself taking part in the education which was so valuable, and again that evening they had heard him within ten minutes deliver a most brilliant address, for which they would all concur in thanking him most cordially.

The CHAIRMAN having acknowledged the compliment, the meeting adjourned.

The *Times* of May 5th contains the following letter:—

"SIR,—Last Thursday, at the lecture I delivered on 'Judicial Reform in Egypt,' which you were good enough to fully report, the Lord Chief Justice of England and other speakers, whilst full of praise of what had been done, somewhat demurred at the scanty teaching of the English language and the consequent scanty use of English law and English lawyers in Egypt.

"I had not the opportunity at the time to explain how matters exactly stood. But I am now in pos-

session of all the facts, and if you are able to give me hospitality, I think the public might like to hear them.

"French was the principal European language in Egypt at the time of the British occupation of the country. No violent change was attempted. There were more important things to be done. Order, security, and good finance had to be established. Moreover, at that time and up to quite recently the French opposed with the utmost vehemence every English reform. Careful choice had to be made of the reforms to be pressed. So the question of the English language was not raised. In 1890, when I went there, the pupils in Government schools who learnt French numbered 3,199, while those who learnt English only amounted to 1,747. 'Linguistic free trade,' to use an expression of Lord Cromer's, was allowed, parents were free to choose French or English for their children, and, as French was in general use and there was at that time no certainty the English would stay in the country, they naturally chose the predominant language.

"A few of us who were perfervid Britons organised a little later on an 'English Language Prize Fund,' and some £300 a year was subscribed by the English in Egypt and distributed to the pupils of the various Government schools over the country who were most proficient in English. But this artificial stimulus had only a very short existence. There was no lack of British zeal and British money. But Riaz Pasha, an old-fashioned Turk, came to power and absolutely refused to allow our prizes to be distributed. Still less would he hear of our annual meeting and public distribution. His advent occurred after we had bought our prizes; they were all stuffed into a big cupboard in the Ministry of Public Instruction, and I should not be surprised if our watches, books, inkstands, &c., are still in that cupboard.

"Lord Cromer would not interfere, so our scheme collapsed. His Lordship, quite rightly, as it seems to me, thought the moment inopportune to take a step which would have irritated not only the retrograde Egyptian Prime Minister, but also the French colonial party, at a moment when larger disputes needed settlement.

"Linguistic free trade, however, has produced excellent results since then. The figures given by Lord Cromer in his last report speak for themselves. The per-centage of French-learning pupils as compared to English-learning pupils in 1889 was 74 to 26. In 1898 the per-centage was 33 French-learning pupils to 67 English-learning pupils.

"The people have realised that the English intend to stay in the country. They will choose the language that is most to their interest to learn, and I feel confident that English will now advance by giant strides. Moreover, Lord Cromer is no longer checked by French opposition at every turn. He has a free hand, and no man in the country is more keen than he is to spread our language throughout the country. It would be useless to declare English a judicial language in the native courts until the judicial, or, at any rate, a majority of the judges, has acquired its use. But that must come very rapidly now that English teaching is firmly established not only in the Government schools, but in the School of Law itself, the nursery of both Bench and Bar.

"Yours obediently,

"J. SCOTT.

"1, Adam-street, Adelphi."

TWENTIETH ORDINARY MEETING.

Wednesday, May 10, 1899; Major-General Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., in the chair.

The following candidates were proposed for election as members of the Society:—

Carter, William Leonard, 51, Aynhoe-road, Kensington, W.

Jennins, Henry Horwood, Crown Works, Leeds, and West-hill, Chapeltown, Leeds.

The following candidate was balloted for and duly elected a member of the Society:—

Lowe, C. W., Summerfield-house, Reddish, Stockport.

The CHAIRMAN, in introducing Mr. George Bunyard, explained with great regret that Sir George Birdwood, who was to have presided on this occasion, was prevented doing so by illness. Mr. Bunyard was the author of "Fruit Farming for Profit," which was now a text-book on the subject, had been connected with fruit growing for 44 years, was Chairman of the Edinburgh Fruit Conference, was for three years Member of Council of the Royal Horticultural Society, and was now Vice-President of the Fruit Committee of that Society.

The paper read was—

FRUIT GROWING IN KENT.

By GEORGE BUNYARD,

Vice-President of the Fruit Committee of the Royal Horticultural Society.

IN THE PAST.

The county of Kent has always held a high, in fact, the foremost position as a fruit-producing centre. So far back as 1826, Hasted, in his famous Kent history (vol. 6, page 291), quotes Lambard, who says, "In this parish of Teynham, with thirty others lying on each side of the great road from Rainham to Blean Wood was in his time (1570) the cherry garden and apple orchard of England," and such it un-

doubtedly continued till within memory. Teynham, he says, was "the parent parish from which other plantations issued; for Richard Hayns, fruiterer to King Henry VIII., having observed those fruit plants, which had been brought over by our Norman ancestors, had lost their native excellence by length of time; and that we were served from foreign parts with fruits on that account, which he saw no reason for, as neither soil nor climate here were unequal to the bringing of them to perfection; determined to try a plantation of them here, for which purpose, having obtained, in 1533, 105 acres of rich land, then called the Brennet, and having with great care, good choice, and no small labour, brought plants from beyond the seas; he furnished the ground with them in rows in the most beautiful order. The fruits consisted of the sweet cherry, from thence usually called Kentish cherry, the temperate pippin, hence, for the like reason, called the Kentish pippin, and the golden renate, which sort, especially the first and last, have long been propagated from these in great quantities throughout the southern parts of this kingdom; but the Kentish pippin is now hardly to be met with even in this county. Pliny in his "Natural History," Book XV., chap. 25, says:– "Cherries were not in Italy before L. Lucullus's victory over Mithridates, king of Pontus; after which (in the year of Rome 689) he first brought them out of Pontus thither to Italy, 120 years after which they were transported into Britain."

Hasted (vol. 12, p. 46) says, apricots were introduced by one Worl, a priest, in the time of Henry VIII., and the red and blue Perdrigon plums and artichokes in Cromwell's time, 1570.

Sittingbourne, where the cherry trees attain gigantic size, and provide the largest and finest fruits, is at the present time one of the best districts for this specially Kentish product. No doubt, Hayns also grew pears, for there is no district that I am aware of, which produces such clean and well-developed pears, as it possesses a cool, deep, rich alluvial soil, and on that account has been largely drawn on by the brickmakers.

Michael Drayton, in his "Poly-Olbion," says (1563-1631):—

"O, famous Kent! quoth he,
What country in this isle that can compare with thee,
Which hast within thyself as much as thou canst wish—
The conies, venison, thy sorts of fruit and fish;
And what comports with strength: thy hay, and corn, and wood,
Nor anything thou wants that anywhere is good?"

The Kentish cherry is grown to this day, also a similar but larger one, the Flemish cherry, both commonly called "reds." They are the Montmorency cherries of France. The golden rennet is one of our finest dessert apples. The Kentish pippin may either be the "Kent Fillbasket," or "Colonel Vaughan," still largely cultivated in Kent.

Gerarde, in his Herbal, 1597, figures six sorts of apples, but the Kentish pippin is not named, though he says:—"The county of Kent has a great many sorts of apples."

The proximity of Kent to the Continent would further account for the best known kinds of fruits of early times being introduced first by the Romans, whose custom it was to carry with them such fruits as they esteemed in their own land. For instance, the Roman station of Reculver (Regulbium) is credited with a blue fig they are supposed to have introduced, which is by experts referred to the Violette de Bordeaux of our gardens, a fig familiar to visitors to the Riviera, which often makes its appearance in our London markets in October and November. Later on, the Norman monks would doubtless bring with them their best fruits to plant in their religious establishments, the remains of which still exist at Charing, Canterbury, Eltham, Rochester, and Northbourne, near Deal, where there is a well-situated walled monastic garden, which is reputed to have been the gift of Ethelbert and his Queen, Bertha, to St. Augustine. It may therefore fairly be stated that from very early times Kent has had the advantage of the best-known fruits, and, through the monks, those elements of cultural skill which (even more than a fruitful soil), tend to make the Kent fruit famous, and give the county the title of "the garden of England." Hasted states that there were vineyards at Barming and Tonbridge.

Passing from primitive ages to the time of the Hanoverian kings, we find that although some few orchards were planted, still there were other field crops, as cereals, potatoes, and roots, which realised high prices and made the fortunes of the farmers of those times; but speaking generally, orchards were neglected, and little or no cultivation was done; apples being mostly grown for cider and pears for perry, two beverages which, later on, were driven out of use by beer, so that we yet find here and there very ancient trees producing fruits the names of which are not even known by experts in our day. At the period before the railways were pushed into Kent (the South-Eastern Railway was made to Dover in Feb-

ruary, 1844, to Gravesend 1845, and the London, Chatham, and Dover, about 1858, tapped the Cray districts, now noted for strawberries), it was manifestly impossible to deliver fruit from Central Kent to the London markets in good condition, and growers could only look to local markets for the sale of their surplus or best fruit, while the inferior apples and pears went to the cider-press. In the district between Dartford and London fruit orchards were numerous, being within easy distance of London; and the North Kent districts largely supplied the metropolis, especially Erith, Bromley, Abbey Wood, and Lewisham. From close observation of old orchards we may conclude that fruit-planting as an industry was neglected for half a century, but was again followed up when railways afforded facilities for transit and new markets were opened in London. In the years between 1840 and 1860 large breadths of new orchards were laid down and the Kent cob nut began to be cultivated, while the new system of raising orchards on cultivated land, with gooseberries and currants beneath the standard trees, came into vogue. This system is called in Kent a plantation (among the rustics, a "platt") as distinct from orchards on grass, which latter were too often grazed by horses and cattle to the detriment of the trees. It is from the older orchards of this date that the markets are now flooded with the bulk of that inferior hard fruit which disgraces our shops, being badly grown, carelessly gathered, and marketed in a slovenly way, affording a powerful lever to those pessimistic writers whose cry of "Oh, fruit does not pay," which comes round as regularly as each Michaelmas term. It were well if these worn-out orchards were grubbed up and the trees used for firewood, although by careful pruning and surface-feeding, excellent examples may be produced, aud the vast bulk pays. Still, from a commercial point of view, the placing on the market of quantities of rubbish depresses prices, and it were wiser to sell all such produce to the cider makers, or if of suitable kinds as Wellington or Goff, to the jam makers for pulp. On the other hand, such old trees, if healthy, might be head-grafted with some of our best modern kinds. The feature of the orchards of this period may be described as haphazard, combined with neglect as to feeding the trees. In many cases, cattle took from the grass orchards all the nutriment, and not being corn- or oil-cake fed themselves, added to the general poverty of the soil. One of our foremost East Kent orchardists states that, until he introduced manure into his orchards, its use for this purpose was quite unknown. Noticing that some of his trees where cattle congregated grew better fruit than others near, he took the hint; and pears of choice sorts in his orchards were quite equal to the same kinds grown in gardens.

In the Present.

Having glanced at the conditions that prevailed in the past, we arrive at the year 1869, when that period of agricultural depression set in, which has been a great factor in turning the minds of farmers and landowners to sources of revenue other than ordinary three or four course husbandry. The gardening press had for some time been dinning into the ears of the public that vast sums of money were leaving the country for the purchase of such hardy fruits as could be grown in Britain. The daily press caught the same spirit, whilst the agricultural papers took up the idea earnestly, but slowly. By degrees this idea became a fact, and those men who went in boldly for fruit-culture at that time have made fortunes; and many labouring men, who had plenty of hard work in them, began in a small way and extended on all sides as they accumulated capital. There was another factor which had to be reckoned with. The removal of the excise duties from hops and malt had so depressed prices that orchards were found to pay better on an average of years than hops or barley; and fruit trees were introduced in the hop gardens in order that when they reached a paying age the hops might be grubbed and the land laid to grass, as before the introduction of foreign mutton and beef, live stock was as yet a safe investment for farmers. For, in a grass orchard, as an old hand once remarked to me, "We get three crops: mutton, wool, and fruit." The growth of soft fruit for the making of jam and preserves, bottling, &c., which had hitherto been a local business, now became a vast industry, and thousands of acres of poor woodland and thin arable lands were adapted to the culture of strawberries and bush fruits in the Swanley and Cray districts of Kent. No small amount of their success in those parts is doubtless owing to the cheap manure which they procure from London, where the authorities very rightly decline to have it stored, and it is this fertilising agent more than the soil itself which has justly made the Swanley fruit a name all over the kingdom.

Fruit-culture then began to be taken up as a serious business, and every advantage of

improved systems of culture was embraced. New kinds of fruits in each family were tested, and their suitability for market, when once known, caused them to be largely planted. The matter of pruning, which we take to be the crux of the Kent system, was carefully developed, and it was found that very much finer examples could be produced by severe pruning, while such fruit made the highest prices. Timely pruning, gathering of the crop at several pickings, with an extra top dressing of manure in summer, gave results never dreamed of before. Growers were not slow in following such evident sources of profit, while new and distant markets became available, as the Northern and Western Railway agents eagerly competed for this traffic; and so it came to pass that strawberries (which are one of the most perishable fruits) could be gathered at Swanley, and put on rail to reach Glasgow and Edinburgh the same day in good order.

My remarks in this division have hitherto referred more to soft fruits (currants, raspberries, cherries, and strawberries), but attention was at the same time given to plums and apples and the hardier kinds of pears, which soon proved themselves to pay handsomely for cultural care, while the introduction of the paradise stock for grafting apples upon, enabled growers to obtain crops from trees three or four years old in bush form. The fruit from such trees, by its proximity to the ground, and by the aid of reflected heat, possessed such beauty, size, and appearance, that even in years when a glut of fruit obtained, the apples from the paradise trees made a good paying price. In fact it pays a farmer to plant them on a 14 years' lease. Instead of the old tall orchard standard trees, plums planted as two year old trees, headed back low for half standards, became the rage, and gave a crop the fourth or fifth year, and by a combination of the plantation system with top fruit, very large returns were secured from a small acreage. A word as to the paradise stock. It is a surface rooting apple found in the central Asian mountains and was named *Malus Paradisica* from its being discovered near the supposed region of the Garden of Eden. This variety, though a weakling by itself, gives great vigour to the apple scions and buds placed upon it, and causes the trees to produce fruit (as before stated) much earlier than trees raised on the crab apple. Heavy crops are frequently obtained on two-year trees and have to be thinned out. All the sorts of paradise apples have this effect except the narrow-leaved French variety, which has such a restrictive action on the scion that it fails to make a paying tree, and unfortunately this fact has in the past caused the apple trees on this stock to be condemned. Our best nurserymen are now well aware of this, and only use for stocks the broad-leaved varieties. In the Royal Horticultural Society trials at Chiswick, it was found that the paradise apple stocks that were not grafted gradually dwindled away, while those which had "taken," or been worked, formed handsome and fertile trees. It is by use of these paradise stocks that nurserymen are able to supply examples in many cases capable of bearing fruit the first season after transplanting, as this paradise stock produces such abundant surface roots that the trees do not suffer on removal.

There is yet another factor that has assisted the culture of fruit in the past thirty years, viz., the introduction of steam for the purpose of clearing and deeply cultivating the soil, in many cases quite equalling trenching. The good work done by the Royal Horticultural Society through its publications, conferences, and exhibitions, has conferred a great benefit on the public by the introduction of novelties and the awarding of medals and certificates to the most deserving kinds. The gardening press has done loyal service in giving information, and the lectures and practical demonstrations by the County Council lecturers have brought home to the people the advantage of culture, and the rational use of preventitive mixtures for blights, insects, &c.

While not agreeing with the American system of spraying with poisonous compounds (as Paris green, and London purple) for orchards and plantations, having regard to their dangerous character, yet the use of winter dressing of lime, soot, and soft soap, and sprays for insects when they appear in spring or summer, is very desirable. Many of our best growers spray as often as four times a year, both as a preventitive and a cure, but a free use of manure, clean cultivation, and care to search regularly for insect blights in order to cure such before they spread, will render drastic measures unnecessary.

It would be well in this place to give the *modus operandi* in forming orchards and plantations as now practised by the best Kent growers. If an orchard be desired on what is now grass land, say cherries, they are planted at 36 feet apart in rows; but in order to reap an earlier return, plums are placed between the

cherries at 18 feet apart, as these commence to bear the fourth or fifth year, whereas cherries are some eight or ten years before they pay to pick. In planting, the turf is removed or dug in, and holes about 3 feet over and $1\frac{1}{2}$ feet deep, are made to receive the trees, which, after planting, are staked, and if cattle are allowed into the orchard they are protected (cradled) with chestnut pales, made square or triangular to keep the heads of the trees from the reach of the cattle. The plums are pruned back the first year, but the cherries are better not cut back until they have made a year's growth. Care is taken to keep grass from rooting in the 3 feet circle, as its presence and penetrating power would otherwise absorb all the moisture necessary for the young tree to establish itself. The orchard trees are summer and winter pruned, and shaped, or balanced for five or six years, until they are fitted to be grown on, with an occasional thinning of the main boughs, and the ties which attach the trees to the stakes are renewed also. In forming a plantation, a field or stretch of ground which has been previously prepared by a crop of potatoes, peas, or greens, is deeply stirred, and the standard or half-standard trees are placed in lines, say 15 feet apart, for plums, small-growing apples and pears, and 18 to 24 feet for the larger kinds. These being planted, give the pattern for the bush fruit, which will then be introduced in long lines at 6 feet apart, so that horse hoes can be used to keep the land clean, all the trees of a kind being planted in a block so that the fruit can be gathered at one time. I strongly recommend that all new orchards be raised in arable land, when for some years a handsome profit can be made from intermediate vegetable crops, wallflowers, &c., the cultivation of which is of great benefit to orchard trees. In the culture of strawberries it is usual to plant after some crop which has been highly manured. The plants are set in spring, or, if favourable, in autumn. An acre requires some 12,000 for a plant at 2 feet apart, 30 inches from row to row. An improved plan now obtains of planting on the square, as horse cultivation can then be used both ways, and thus hand labour is saved.

The Kent Cob Nut is very extensively grown in Kent, where the largest-sized nuts are produced; being a hardy subject, not particular as to soil, many steep banks and stony patches of land that will not grow better fruits are planted with trees at 12 to 15 feet apart, and for some years until the cobs require all the ground, vegetable crops or bush fruits are grown between them, which being highly manured help the nuts to form trees. They begin to crop the third year; many old plantations are found with trees 100 years old, some 24 feet through, and not more than 6 feet high, as they are severely pruned to keep the trees in the form of an inverted umbrella with about 9 to 12 main branches, all coarse wood being pruned away, as it is from the young spray that the nuts are produced. The female blossom appears in February and the male catkins or polliniferous flowers are best left on (or at least a portion of them) until the blossom is set, say March, before the winter pruning is carried out. They are also pruned in August, taking out the strong "wands" which are used for packing, and the top surplus growth is then broken off. A good plantation will yield $\frac{1}{2}$ ton to the acre, but we have had two or three good years (1896-7-8) when crops have reached to $2\frac{1}{4}$ tons. Prices vary from 25s. to 60s. per 100 lbs. Standard apples and plums are often planted over them, and this gives a larger return per acre, but cobs are best alone, though they succeed fairly well under trees. Cob nuts will also flourish in good ground (soil), but that is usually reserved for choice fruits and too gross growth is not favourable to their cropping.

Birds.—I shall naturally be expected to give some opinion on this point. As far as birds are concerned, if all possible means are taken to destroy sparrows, and all bullfinches are trapped, the other birds' toll of fruit may be given them willingly for the general good they do in keeping down grubs and insects. I speak generally, as I am not unmindful of the attacks of starlings, blackbirds, and thrushes on our soft fruit crops. The cuckoo is one of the fruit-grower's best friends, as he alone will feed on the gooseberry caterpillar, while all the soft-billed migratory birds are insect feeders. I fear that in many places as much harm is done by the gun in causing canker, broken boughs, and twigs, as the birds themselves would do. It is to be regretted that such a handsome bird as the bullfinch must be destroyed, but he is a silly fellow and can be readily trapped alive, and there is a sale for good cock birds in all our large towns.

Insects.—To deal properly with the subject of injurious insects affecting fruit trees and bushes would require an evening by itself, and I can only here suggest that adequate manuring of the soil, burning all prunings and rubbish as soon as collected, combined with a winter washing of lime, soot, and soft soap on

the older trees, will to a great extent check insect ravages. Spring and summer spraying will be necessary for red spider on gooseberries, aphis in plums and damsons, and black aphis in cherries as soon as any insects are observed; they are readily seen, as the leaves curl on being attacked. Special formulas are given in most fruit books, but the safest remedy for spraying is soft soap and quassia. Where winter moth is prevalent, orchard trees must be grease-banded, care being taken to place a ring of grease proof paper on the stems before greasing.

In the Future.

Without in any way venturing to prophecy we have seen enough of the success of the best fruit growers, to outline in some degree the probable course of commercial success in the future, for it is to the newly planted orchards, where the sorts are of the best for their special purposes, and where clean cultivation obtains, that we must look for our chief supplies in time to come. In America and Canada, they consider 15 years the average life of a paying orchard; the trees are then destroyed, and a fresh start made. In this country 25 to 30 years may be considered as the outside limit, and by that time the available nutriment in the soil may be considered to be exhausted by the standing trees.

It will, therefore, be well before that time expires to provide other orchards to replace the condemned patches. This may appear to many a drastic proposal, but the stimulating manures now given tend to strong sappy growth, therefore I think I have not overstated the case. Again the public is fast being educated to distinguish between good and inferior fruits and growers will find their future profit to lie in producing examples of the finest sorts.

At present, colour is the market factor in apples more than quality, red and yellow being chosen for dessert, and green or golden for kitchen sorts, and expert observers will notice that this excludes many of our best flavoured fruits, which being russety, or of a nondescript appearance, do not sell on the market boards, though where quality is asked for, they cannot long remain unknown. We may look also to improved methods of packing to secure higher prices. Instead of the half-sieve (four gallons) and the sieve baskets, choice fruits should be boxed and placed in punnetts and suitable packages, so that on reaching their destination they need not be again handled before reaching purchasers. Many advocate a non-returnable wooden box, such as is used for oranges. A start has been made with ripe gooseberries, white currants, und raspberries in punnets, and good prices result. The best strawberries are of course marketed in ½ lb. and 1 lb. reputed punnets. I think also that the use of artificial manures suitable for special soils and crops must engage the attention of growers in the future. It is evident, from the use of kainit, soot, fish guano, basic slag, and rich portable manures, that the fertility of the land must be increased and retained, while with such manures, the crop of weeds which so often follows the use of stable manure may be avoided. There is another way in which growers should copy American producers, and that is by planting large bulks of one sort of either plums, apples, or pears, so that day by day buyers can make sure of a supply of the same article. The wisdom of this is seen in the fact that when a retailer gets an apple that suits his customers, and they have taken a fancy to it, the supply is often gone, and he buys another sort, which has to be tried before the public will take to it freely; whereas if a salesman were able to say "I shall have this sort for 14 days or so," the retailer could better gauge his wants and suit his customers. This also applies to plums, and in fact to all fruits. As I have before stated, all old and worn-out orchards should be destroyed, as I feel confident that, with the vast quantity of improved sorts which the nurserymen of the present time have distributed, there will be no paying market for inferior fruit. The fruit of the future, again, must be carefully gathered, evenly sorted, well stored, and honestly packed; those men whose character is known on the market can always make the best prices, and any sharp practices in the way of mixing sorts and topping-up always recoil on the sender.

In reference to the storage of fruit. I have here photographs of a fruit room, which has enabled apples in fine condition to be exhibited as late as the latter days of May. I do not pretend that such erections are necessary for market fruit growers, as in Kent we have ready-made rooms in the abundant hop oasts and stores of the county, and many contend that fruit marketed direct from the trees pays best; but the principle can be observed even in existing stores, which is—simply gather the fruit with care, only store perfect examples, keep the fruit in the dark and never let the stores be too dry or allow the frost to enter. Cultivators must also test new

ınd improved varieties, and when found to suit :heir soil, embark in them largely. I am not ıopeful of the progress of evaporated (dried) ınd crystalised fruit in this country, nor do I .hink that apple-rings are likely to pay the ›roducer.

It must be remembered that the prunes of he Continent are really partially dried and ›repared on the trees, in consequence of greater sunshine; and in drying experiments I ıave witnessed even our large plums come out ›f the ordeal—to use a common expression—all ;kin and bone.

Growers, too, must look further afield for ›utlets, and I feel that the system of sending ;uch huge bulks to London markets, only to be ranshipped to other cities and towns, is loomed. Our largest growers pack their ruit, to suit distant markets, in baskets, ›arrels, or cases, as the particular market ıffects, and send it direct from their local tations instead of to London first, and thus nake the best prices. It is obvious to all that here is neither time nor space in the large ondon markets to deal with the vast quantity hat is sent there in busy seasons.

These remarks, however, are in no way inended to disparage London markets or ondon salesmen who do their very best for lients; but the course indicated will save those luts of produce in the London market, and revent lowest prices. London will always be vell supplied, and can consume a vast quantity, ut producers on either a large or small scale vill find it pay best to send the best only for ondon sale. It is manifestly unfair to send he best only to distant markets, and the inerior to London, because the carriage is less, or it is a known fact that (as a rule) London uyers always give higher prices for picked uit than provincial markets realise. There is growing demand for fruit jellies, flavourings, emperance drinks, jams, preserved and bottled uits, and further developments of these inustries are to be looked for, not only in a trade ense, but in private families, as the process now so simple with the new and improved utomatic bottles. I have not touched on ie culture of fruit under glass, because it is ot within the scope of this paper. The most rosperous branch of this culture is no doubt ie growth of peaches and nectarines. But e yet require more time to know what effect ie maintenance and repair of the comparavely flimsy glass structures of the market rowers may amount to, before we can conder the matter tested to an issue. Tomato growing is really properly treated as a vegetable industry, though on the border land between a fruit and a vegetable

It will be observed that I take an optimist forward view of this industry of fruit culture. Quite agreed. And I can go further, and say that no grower who has entered on the matter in a business way has ever failed to make a profit, naturally largest where most care is taken. Cases of failure are known, but they can be traced to a want of ordinary business acumen, and are often the result of following false leaders, or the development of a fad.

Fruit Sales by Auction.—These sales in Kent are looked forward to with great interest by buyers and sellers. Cherries are generally sold first, on the trees, and the competition is often very keen for choice lots. They have been known to make £80 per acre, but that is an exceptional price. Plums are often included. Bush fruits and strawberries are sometimes sold by auction where the grower prefers a certain price "cash down" to the chances of market sales. All these are called soft fruit sales, and later on pears and apples are also sold by auction as hard fruits. In these sales the buyers are either local men who make it a trade, or London salesmen who have made contracts to supply buyers. The buyers take all risks, the sellers getting ready-money and safe-guarding themselves by the customary rules as to damages. It is not advisable to sell fruit by auction from trees under ten years old, as naturally buyers' pickers are not so careful in gathering the fruit as the owners would be, and young trees are apt to be seriously damaged by heavy ladders being used. The growers pick young trees with step-ladders, which stand without the support of the tree itself.

The Kent System in other Counties.—My visits to various fruit centres have impressed on my mind the fact that we in Kent do not enjoy a monopoly of the best soils and situations, and it is certain that where the Kent systems of pruning and culture are faithfully carried out, there are thousands of acres of available land that could be profitably brought under fruit culture. This is demonstrated in many distant counties, where the orchards have been started with healthy young trees, the results astonishing the planters. I, as an expert, receive very fine fruit for naming from even Scotland and Ireland.

Social Aspect.—It will be conceded that the growth of fruit has had a marked effect on the health of the middle and lower classes,

and has also, I believe, helped the cause of temperance. This is due honour to sanitary engineers and authorities, I claim that the health of the large towns and cities has been appreciably improved by the fact that good wholesome fruit can now be purchased at a cheap rate, a remark which covers oranges and foreign produce also. It is admitted that the extended culture of fruit has perceptibly raised the standard of living in Kent, as among the rural population, so much can be earned by the women, girls, and boys, combined with the higher wages paid as piece-work to the fruit men who live in the county, that the villagers are better fed and clothed than they used to be. At the same time fruit-growing prevents that depletion of villages which goes on in other places, while the general prosperity of the country is increased. This is also a national matter, because the best soldiers and sailors are found in recruits reared in the rural districts. It is well known that large numbers of fruit pickers spend the summer months in Kent, coming from London and other populous towns, who, we fear, do not always take much cash back with them, but doubtless their health is benefitted by the open-air work.

Probable Profits.—Hitherto I have spoken of practical matters relating to culture and disposal of produce. Naturally some idea of the profits of this industry will be looked for, and I feel unable to give these with any approach to accuracy because the information at my disposal has been rendered to me confidentially; and to speak of some of the large returns made would be unfair without discounting these results by losses through bad years, caused by wet seasons, late spring frosts, summer blights, gales, &c. Therefore, to arrive at an estimate it is best to take three years' profits and average them, when the result will work out as follows:—

Cherry	orchards on	grass,	per acre,	£20.
Apple	,,	,,	,,	£15.
Mixed	,,	,,	,,	£15.

These estimates are for established orchards in full bearing, and such would probably pay the rent if used as grazing land for sheep independent of the top fruit crop.

	Per Acre.
Mixed plantations with top and bottom fruit over four years old	£20
Gooseberries alone	£25
Raspberries ,, ...	£20
Red Currants ,, ...	£12
Black ,, ,, ...	£15

It will be readily understood that much depends on the state and condition of the orchards, and it may be remarked that these average profits are frequently doubled and trebled, while absolute losses are comparatively rare.

The cost of establishing a grass orchard is variously estimated at £15 to £20 per acre for the first year's outlay. If on arable land (as before stated) the outlay may be recouped by vegetable crops before the land is laid down to grass. The expense of establishing a mixed plantation is placed at £30 to £40 per acre. In the latter, an earlier crop amply repays for the extra initial expense. In estimating profits some experienced farmers consider seven years a better average, as they fear that a less term is too short; as profits are sadly discounted by such indirect causes as strikes, epidemics, cold seasons, and wet weather.

The Kent System of Tenure as Between Landlord and Tenant.—The rule about Mid Kent is for the landlord to pay for such permanent trees as the tenant elects to plant. Some landlords also further allow a sum for planting and staking. Having first arranged with the agent or steward, the tenant is bound to plant, protect, and keep in order all such permanent trees. But if the tenant makes a plantation, he furnishes all the bushes, canes and plants necessary at his own expense, and at the expiration of the tenancy he has no claim on the landlord for his outlay. This is a simple matter, and has worked well when the tenancy is 14 years or more; but if a tenant dies, or leaves before the expiration of his lease the bushes are valued to the incoming tenant as tenant right; or the landlord pays for them and gets the sum from the new tenant, or should he be unable to pay, an extra rent is charged to cover the landlord's outlay. The passing of the Market Gardeners' Act, 1895 placed tenants who have planted in the past on a firmer footing, as under it the outgoing tenant can claim compensation for his outlay (before 1895); which is assessed by valuation if tenant and landlord are unable to agree as to terms.

It frequently occurs that valuers' estimates differ widely, and a third man, as arbitrator has to be consulted. I think in all cases a proper understanding should be arrived at on entering into a tenancy, and from experience I believe nearly all landlords and agents are ready to meet the wishes of a tenant possessing capital and energy. In order, however to guard against an unfair advantage being

taken by an improving tenant, it is customary on many estates for the words "under no circumstances shall this tenancy be considered as a market garden" are inserted in most leases. In other cases where the tenant finds the trees and plants, it is not unusual for an agreement to be made whereby the tenant at the end of his term receives a capitalised sum equal to — years' purchase on the increased letting value of the holdings, as then determined by agreement or valuation. In my opinion the Act would have been improved if a definite number of years had been fixed under which compensation could be claimed, as bush fruits are practically useless after 10 to 15 years, plums begin to decline after 25 years, and apples after 60 years; but under a 14 years' lease a tenant should have reaped his profit on all outlay except perhaps on a cherry orchard. Undoubtedly the best plan is for the tenant to be a freeholder.

Foreign Competition.—The imports of fruit from the Continent, such as early cherries, gooseberries and plums, &c., are variously viewed by dealers. Some maintain that they prepare the public to anticipate our British produce, others that foreign fruits depress the values of home produce. I ventured to say in 1881 that the time would come when the improved qualities of our home fruits, and the larger quantity grown would make it impossible for foreign growers to see a profit. This has already come to pass in grapes, where home growers have ousted most of the imported grapes, and as the bulk of glass-grown vines gets larger year by year, we may look for still further decrease in the supply of foreign grapes in our markets. One Covent-garden salesman sold four tons of English grapes the week before Christmas, 1898. Apples from America, Canada, and New Zealand, although facilities are offered for transit in many cases, often fail to pay the growers, though carriers and salesmen may reap a rich harvest, and it is evident that growers will not continue to send here if unremunerated for their trouble. Again the home demand for these fruits in such expanding countries and colonies gets larger year by year, and these two factors combined may give hope and courage to the home grower. As regards Tasmanian fruit, it reaches us after our own stores are exhausted, and thus with supplies from the Cape of Good Hope and California does not compete, but merely lengthens the season for hard fruits. In soft fruits, the home growers have little to fear, as the superior quality of home grown cherries, gooseberries, and currants will be always appreciated, and the strawberry is practically untouched by foreign exports.

We are often told by croakers, "Oh yes, but fruit-planting is only, after all, a fad, and is sure to be overdone." I reply to this by stating that the largest planters are those who have already great breadths of fruit themselves, and holding as they do up to 1,000 acres, must be very good judges of the trend of future trade. Probably owing to higher prices, the imports of apples and pears into Britain for 1898 show a large increase, apples being 231,324 bushels more than 1897, and pears 7,059 more than 1897, the totals being 642,278 bushels of apples, aud pears 18,951. Plums, on the other hand, although a short crop in Great Britain, were 266 bushels less than 1897, the total of 338 bushels being quite insignificant. I believe there was a cold spring on the Continent, so that they had little to send in 1898, and doubtless better prices obtained in their own local markets. I may here reiterate that it has been the opinion of many of our largest growers that when our acreage of fruit was large enough to provide for the wants of our population, prices, though still remunerative to the British grower, would fall so low that the foreign grower would not be able to send his fruit over at a profit. This has apparently come to pass in plums and grapes. In pears, we shall always be to a great extent dependent on the Continent, as our acreage of first-class pears is small, and, moreover, the pear is not so hardy or such a regular bearer as the apple. For example, two rows of pyramidal trees in a local garden gave 100 bushels in a good year and not more than ten bushels a year for the following two years. In apples, we must always remember that a large proportion of the 650,000 bushels imported are Tasmanain and Nova Scotian, which come after our main crops are exhausted, and are mostly dessert kinds. The foreign apples do not, as a rule, suit the cook, as they become leathery in puddings and tarts, and do not mellow or melt as our British produce does, so that the later British kitchen apples always make good prices. Where suitable stores are at hand apples pay for keeping. There, however, appears to be an opening for first-class apples after Christmas for the best Pearmains russets, &c., which (as stated) the public yet require some further education to appreciate, as they are mostly dull in colour and do not appear to advantage against the brighter imported fruits though much superior in flavour.

While I, as a Kentish man, have travelled through England I have been struck by the vast expanse of country where hardly any fruit is grown. Bearing in mind the teeming populations of the large northern manufacturing centres, the collieries of Wales and the north of England, it is evident that there is and must be a growing output for all produce grown; being after all produced in a comparatively small area.

Cider.—As already stated in olden days cider was largely made in Kent, and most old farmhouses had a cider press, but beer has now almost entirely taken its place as a local beverage. Your Society has already had a paper from Mr. C. Radcliffe Cooke, M.P. for Hereford, and I need not further allude to the subject, except incidentally, to mention that during the past few years it has been taken up by a Society in the Swanley district of Kent, which commands a ready sale; but they import some of their fruit from Somersetshire and Herefordshire, although, on the other hand, many tons of fruit find their way from Brenchley and Paddock-wood orchards to the Norfolk cidermakers, who certainly turn out a beverage that is refreshing and agreeable to those who are not born in a cider country, and who do not know the crucial points of excellence. Cider-making undoubtedly helps the prices of Kentish apples, large bulks of good sorts, but not of a size quite up to market sale, being sold for cider, relieve the London markets. The Hereford makers, however, maintain that unless special "vintage" fruit is mixed with our Kent apples the cider will not keep, because of the absence of tannin.

In conclusion, I would state that naturally the time at my disposal will not allow me to go into further particulars, but there are many useful pamphlets printed on the culture of fruit for market, and further details can be found in them and be studied at the reader's leisure. There is also much suitable information in the descriptive catalogues published by nurserymen who make the growth of fruit trees a speciality. Attached is a list of what we in Kent consider the best market sorts as distinct from the more choice fruits which are cultivated in gardens.

To indicate the interest taken in fruit culture by cottagers and small holders of land, no less than 50,000 lists of fruits in leaflet form with hints for culture have been sold by the Royal Horticultural Society, and a new edition is now issued and sold cheaply to county councils the clergy, &c.

TABLE OF WEIGHTS AND MEASURES FOR LONDON MARKETS.

Sieve, 8 gallons; half-sieve, 4 gallons; pecks, holding 12 lbs.; punnets, ½ lb., 1 lb., and 4 lbs.

FRUIT IS MARKETED THUS:—

Apples—Kitchen and dessert in sieves, choice desser in halves.

Pears—Choice in halves, common in sieves.

Plums—Damsons in halves, gages in pecks an halves. Plums in halves.

Cherries, gooseberries, and currants in halves, con taining 24 lbs. nett.

Raspberries, without stalks, "slipped" or "plum med," in tubs 30 lbs. and 50 lbs. each.

Strawberries in gallons and pecks, choice in ½ lb. an 1 lb. punnets.

Dessert gooseberries, ripe in 1 lb. punnets an gallons.

Choice pears in boxes of 2 doz.

Raspberries, with stalks, for dessert, 1 lb. punnets.

Cob-nuts in sieves of 50 lbs.

VEGETABLES.

Potatoes—New, in 1 cwt. bags, or sieves of gallons; old, in 1 cwt. bags (2 bushels), or at pe ton.

Greens—Brussells sprouts in half-sieves.
Headed cabbages, 60 to a tally in pads and crates.
Cauliflower, 60 to a tally in pads and crates.
Collards, in bunches of 12, at per doz. bunches.

Onions—Per 1 cwt. bag.

Parsnips—Bunched or per ton.

Carrots—Bunched or per ton.

Turnips—Early, in bunches; late, in 1 cwt. bags.

Celery—Per doz. heads.

The markets for vegetables of all kinds vary fror season to season, and the leading kinds only ar quoted in the reports.

DISTANCES TO PLANT.

Orchard trees, standard apples, cherries, pears, o plums in orchards should be planted about 15 to 3 feet apart, and must be well staked and protecte from rabbits and stock.

NUMBER OF MARKET TREES REQUIRED PE ACRE:—

1,210 at 6 ft. apart—Closely pruned pears on quince or apples on paradise, and for gooseberries an currants.

680 at 8 ft. apart—Apples on paradise (every othe one to be moved in a few years).

435 at 10 ft. apart—Feathered apples or plums.

303 at 12 ft. apart—Permanent bush trees, pyramid and nuts.

193 at 15 ft. apart—Standard plums, damsons, or red cherries.
134 at 18 ft. apart—Ditto.
108 at 20 ft. apart—Standard apples, pears, &c.
75 at 24 ft. apart—Ditto and cherries.
48 at 30 ft. apart—Cherries where pastured underneath.
40 at 36 ft. apart—Cherries or apples.
36 at 40 ft. apart—Cherries or strong pears.

In plantations where there is both a top and bottom crop the standards may be placed at greater distances, noting that the apples and pears give a heavier shade than plums.

Strawberries for market (about) at 1½ ft., 19,350; at 2 ft., 11,000 per acre.

LIST OF BEST PAYING MARKET FRUITS.

Apples.

Those marked * are recommended for orchard standards, the rest as plantation bushes or pyramids on paradise stocks. † These are suitable for either purpose.

Dessert Apples to sell direct from the tree.

†Mr. Gladstone	July-August
†Beauty of Bath	,, ,,
Yellow Ingestrie, or Summer Golden Pippin	September
†Devonshire Quarrenden	August
†Colonel Vaughan	Sept.-Oct.
Lady Sudely	Aug.-Sept.
†Worcester Pearmain	September

Dessert Apples which require to be stored for a time before Marketing.

†Duchess Favourite (or Duchess of Gloster)	Sept.-Oct.
†King of Pippins	Oct.-Jan.
†Cox's Orange Pippin	Nov.-Jan.
†Gascoyne's Scarlet Seedling	Nov.-Feb.
†Cox's Pomona	Oct.-Nov.
†Baumann's Winter Rennet	Dec.-Jan.
†Cockle's Pippin	Oct.-Nov.
†Allington Pippin	Nov.-Feb.
*Duke of Devonshire	March-May

Kitchen Apples which require storing before Marketing.

†Stone's, or Loddington	Aug.-Dec.
†Warner's King	November
†Lord Derby	Nov.-Dec.
*Queen Caroline (or Brown's Codlin)	Oct.-Dec.
*Tower of Glamis	Oct.-Dec.
*Wellington	Nov.-Mar.
*Winter-Queening	Dec.-Feb.
†Bismarck	Oct.-Jan.
*Newton Wonder	Nov.-May
†Graham's Jubilee	Oct.-Mar.
*Bramley's Seedling	Dec.-April
*Golden Noble	Nov.-Dec.
Lane's Prince Albert	Nov.-April
*Hambledon Deux Ans	Mar.-May
Northern Greening	Jan.-Mar.
*Hambling's Seedling	Dec.-Mar.
*Alfriston	Nov.-Mar.

The following make grand trees and bear regularly when about 20 years old. A proportion should be placed in every grass orchard :—

Blenheim Orange	Nov.-Feb.
Kent Fillbasket	November
Striped Beefing	Nov.-Feb.
Mère de Ménage	Dec.-Jan.

Kitchen Apples to market direct from the tree.

†Early White Transparent	July-Aug.
*Early Julian	Aug.-Sept.
†Potts' Seedling	,, ,,
†Lord Grosvenor	,, ,,
†Lord Suffield	,, ,,
†Keswick Codlin	,, ,,
†Early Rivers	,, ,,
†Domino	,, ,,
†Duchess of Oldenburg	,, ,,
†Ecklinville Seedling	Sept.-Oct.
†Grenadier Codling	,, ,,
Manks Codlin	,, ,,
†Golden Spire	Oct.-Dec.
Stirling Castle	Oct.-Nov.
†New Hawthornden	Nov.-Dec.

The softer kinds of apples are best for local sales as they bruise in transit to distant markets.

Pears.

Market Pears for orchard trees.

Hessle	September
Crawford, or Chalk	August
Jargonelle	,,
Williams Bon Chrétien	September
Dr. Jules Guyot	,,
Pitmaston Duchess	Oct.-Nov.
Fertility	September
Beurre Bosc	Oct.-Nov.
Beurre Capiaumont	Sept.-Oct.
Catillac (for stewing)	Dec.-Mar.
Vicar of Winkfield	Dec.-Jan.

Pears as bush trees on quince stock.

Beacon (Rivers)	August
Williams (Bon Chrétien)	September
Dr. Jules Guyot	,,
Souvenir De Congrès	,,
Conference	October
Marguerite Marrillat	,,
Louise Bonne of Jersey	,,
Pitmaston Duchess	Oct.-Nov.
Marie Louise d'Eucle	,, ,,
Buerre Clairgeau	,, ,,
Emile d' Heyst	,, ,,
Durondeau	,, ,,
Princess	,, ,,
Buerre Jean van Geert	November
Fondant de Thirriott	Nov.-Dec.
Doyenne Du Comice	Nov.-Dec.

The list mentioned on quince stock can also be grown as standards where the soil is suitable for pears, and many other kinds grown in gardens can be introduced to meet any special local demand.

Plums.

Profitable Market Plums, either as standards in orchards or as half-standards and bushes in plantations.

Rivers' Early Prolific	July-Aug.
Czar (Rivers)	August
Heron (Rivers)	,,
Early Orleans and Prince of Wales	,,

(*Only in places where they succeed.*)

Belgian Purple	September
Belle de Louvain	,,
Black Diamond	,,
Curlew (Rivers)	,,
Jefferson's Gage	,,
Smith's Blue Prolific	,,
Bush Plum of Kent	,,
White Magnum Bonum	,,
Oullin's Golden Gage	August
Pond's Seedling	September
Victoria or Royal Dauphin	August
Sultan	,,
Early Transparent Gage	September
Wyedale	Oct.-Nov.
Monarch	Sept.-Oct.

Green Gages require a favourable situation. The best are—

Denniston's Gage	August
Early Transparent	September
Bryanstone's late Gage	,,
Late Transparent	,,
Jefferson's	,,
Old Green Gage	August
Cambridge Gage	September
Coe's Golden Drop (late)	Sept.-Oct.

Damsons.

Bradley's King. Hereford Prune. Frogmore (large). Shropshire. Farleigh Prolific, or Crittenden.

The above damsons are in fruit in September and October. Useful to shelter plantations on the exposed portions.

Cherries.

For Orchard Standards. (It is useless to plant less than an acre as they do not pay to look after, scare birds, &c., on a less area.)

White and Amber Hearts.

Frogmore Early	Early
Elton Heart	Early
Kent Bigarreau	Medium
Napoleon Bigarreau	Late
Florence Bigarreau	Late
Emperor Francis	Late
Ludwig's Bigarreau	Early

Red Sorts.

Kentish—Medium. Flemish—Late. Morella—Late

These can be used as standards or bushes.

Black Hearts.

Old Black Heart	Early
Black Eagle	Medium
Early Rivers	First Early
Cluster or Carrone	Late
Werder's Black	Early
Waterloo	Medium
Black Tartarian	Late

Bush Fruits.

Currants.—Black Naples, Baldwin's Black, Lee's Prolific (black), New Red Dutch, Raby Castle (red).

Raspberries.—Norwich Wonder, Bunyard's Superlative.

Gooseberries.—Lancashire Lad, Winham's Industry, Red Warrington, Crown Bob, Keepsake, Rifleman.

Strawberries.—Royal Sovereign (early), Eleanor (late), Sir J. Paxton, President, and Laxton's Monarch, for local sale where they succeed. British Queen, Latest of All, and Dr. Hogg.

DISCUSSION.

The CHAIRMAN said Mr. Bunyard's observations as to fruit growing in the past were of great value, showing how apparently careless some of our fruit growers had been in the years gone by, when its cultivation had not been of so much importance as in the present time of agricultural depression; a depression which had driven farmers and landowners to set more store on the cultivation of fruit, which was found in many places to pay better than hops or barley, as was the case at Swanley in Kent, where the fruit had evidently a name widely known and appreciated. Mr. Bunyard had very properly drawn attention to timely pruning, which, as he said, had given most successful results, and also to the introduction of steam for the purpose of clearing and deeply cultivating the soil, as well as to the good work done by the Royal Horticultural Society in encouraging an industry which was likely, year by year, to attain the great and profitable proportions predicted by the late Mr. Gladstone and other equally eminent men who had taken an interest in the matter. He regretted to hear what Mr. Bunyard said as to the sparrow, a bird he had hitherto deemed to be the happiest in the world, not being fit to eat, and therefore being a part of creation which nobody troubled about; and whatever might be said as to the country sparrow, he hoped the cheery town sparrow might at any rate be spared. Mr. Bunyard's observations as to the destruction, after a given time, of orchards and the planting of new ones were of great value—especially at a time when the fruit competition from our colonies was so keen and had a tendency to oust from our markets

uit grown from worn-out trees such as adorned ıany of our own orchards. There were thousands of :res in this country which might well be devoted to uit-growing, at a profit, under proper direction and ıpervision. In fact, we might learn a lesson from ıe active little island of Ceylon, which, when coffee iled some years ago, changed the cultivation to epper and tea with enormous benefit. As to cider, s manufacture was undergoing great improvement; ıd he trusted that the absolutely careless manner in hich apple orchards and apples were treated in)evonshire and elsewhere might soon be a thing of ıe past, and that cider would soon reach such a andard of excellence as would render it more and ore popular with all classes. They would all agree ıat papers by practical men, such as Mr. Bunyard, ere of great use to the Society, and of considerable ılue to the community at large—especially on a ıestion such as fruit-growing, which, in his opinion, ıd a great future before it.

Mr. W. W. BERRY said it had given him great leasure to listen to this paper, and he might say that ı this subject Mr. Bunyard was a prophet, not withıt honour, even in his own country, and the tenant rmers and landlords of Kent would always be ateful to him for the pioneer work he had done, for ıe advice he had given, and for the indomitable erseverance with which he had carried out his periments over many years. The question of lection and packing of fruit was all-important. If had 100 bushels of apples from a tree, he would ther send 60 per cent. of the best, even if he had to row away the other 40 per cent., but that was not all necessary. If you picked out the very best, say) per cent., and packed them carefully in boxes, and en took a further 40 or 50 per cent. and packed them refully in baskets, the returns from those two sections ould be greater than from the whole 100 bushels arketed in a careless way; there would be a saving carriage, in packing, and in other ways, and you ould still have 30 to 40 per cent. of sound fruit to al with, which you could dispose of to the smasher," as the jam maker or cider maker was rmed, at a fairly remunerative price. The same ing would apply to every kind of fruit. Another ıprovement was the steam cultivation of the land, ıt only in clearing old woodlands, but even on some the best land in Kent, where he would not think of anting fruit trees without first thoroughly ploughing and stirring the subsoil by steam. He recently broke 14 acres, first ploughing it 9 to 12 inches deep by eam, and then following the burrows with a powerful eel implement to break up the soil underneath, ing careful not to bring the subsoil to the top, but oroughly breaking it up from 21 to 24 inches deep. ıe whole cost was not more than £2 per acre, you hired the implements, and that was quite saved the cost of planting. Artificial manure was another portant point. Any farmer or fruit grower could w be supplied with exactly the manure his land or crop required, and at a moderate price—either prepared bones, guano, or some of the phosphatic manures which had been referred to. One of the principal reasons for which he would recommend these things in preference to farm-yard manure, was the economy in application. Apart from the question of weeds, which was very serious, especially with manure from London, the expense of hauling 20 or 25 tons of farm-yard manure on to an acre of fruit land, getting it to the plantation, and then getting it out and in amongst the fruit bushes was enormous, whereas if you had a suitably-prepared manure, with the proper quantity of potash, phosphates, and ammonia, it would all go in a one-horse cart and be carried out and sown broadcast on the land for three or four shillings. On a large scale that saving alone would make a good living for the fruit grower. With regard to foreign competition, there had been complaints for 25 years, but he thought the time had come to admit that the British fruit grower was largely dependent on the foreign and colonial produce. In the old days a small quantity of fruit could be sold during the season; there was a shop here and there, and fruit was very dear, and when any unusually large quantity was sent to market there was no one to distribute it. The season then only lasted three or four months, but now we had choice fruit all the year round. There were hundreds of shops, stores, and barrows—fruit was constantly put before the public, who were thus educated to the consumption of it, and insisted on having it, and thus the fruit-grower was far better off than he would have been without the foreign supplies. Reference had been made to the advantage of fruit and hop growing in keeping labourers on the soil, which was a matter in which he took great interest. Things were looking up a little in every branch of agriculture, and they wanted more labourers than they did a few years ago, but they could not get them. They were often in great straits for men to do a little extra work which they knew would pay for doing. If you went away from the most prosperous districts, up into the hilly and barren parts, you would find only one in three, or one in six of the cottages occupied, but down where fruit and hops were grown, and near the towns, there was an enormous dearth of labour. Instead of getting the assistance they used to have from the hill country, when there was any extra work, they could not now find it. In the villages where fruit growing was carried on, there was work during the winter in pruning, manuring, digging, making new plantations, and so on, and he was paying £1,000 in wages now, where £100 was paid when he was young; and a house could not be got for love or money, though five miles away there were empty houses, because there was no work for the men to do. The fruit industry, therefore, was a grand thing, and it must be the same in many other counties. Fruit was becoming more and more popular every day; it had never been overdone yet, except in one year, 1886, when there

was the biggest all-round crop of fruit ever known, and at that time the system of distribution had not developed in proportion. There might be a crop now three times as big as that, and it would all go to market, and the public would get the benefit of it. Enormous quantities of hothouse grapes and tomatoes were now produced in this country. Mr. George Munro had given evidence before a Parliamentary Committee that in one year he had sold 700 tons of English-grown hothouse grapes, in addition to those from the Channel Islands, and more than 1,000 tons of tomatoes.

Mr. J. Ashbee said it was perfectly true, as the last speaker had said, that it was much better to keep inferior fruit out of the market altogether, than to put it in with the better class. He had repeatedly seen the sale of good apples entirely spoiled because certain growers thought that they could get the better of the public by putting inferior ones in with them. There were two distinct classes of buyers: the man who bought the best and gave the best prices, and the man who bought the worst and only paid the lowest price. If you sent a mixed lot, the good man would not look at it, and consequently the lower-class buyer must have it, and he would only take it at his own price, and thus the grower often did not realise the cost of carriage, simply through carelessness and stupidity in packing his goods. Foreign competition in fruit was like foreign competition in everything else—cereals, hay, straw, eggs, butter, cheese, or poultry. Foreign fruit could not be kept out of the market, and it answered a very useful purpose. No doubt, it had stimulated the public taste for fruit; the more fruit people ate, the more they liked it. He had often wondered what our forefathers did for fruit; the people, generally, could have had hardly any. He could remember the time when the only thing you could get in winter was an orange. The colonies were making great strides in this direction. Cape Colony had recently come to the fore, and within a decade would be sending fruit here which would be a surprise to many people. But it would come in when the English fruit was over. English grapes were now just finished, and there would be a good opening for grapes from the Cape. They had a few this year, but nothing to what would be sent in a year or two. It was the same with apples, which were just beginning to arrive. Men had gone to the Cape from California, who were laying down hundreds of acres of land in fruit, and they would be sending thousands of packages before many years. But it would do no harm to English fruit, which was equal to anything in the world when well grown and properly sent to market.

Mr. George Gordon, V.M.H., said the course advocated by Mr. Berry of cultivating the land for fruit-growing by steam, was much better than what was described in the paper as the usual plan in Kent, namely, making holes, planting the trees, and keeping the surrounding space fr from grass and weeds. It was much better t thoroughly pulverise the whole soil, so as to allow the free growth of the roots. A cultivated orcha was preferable to a grass orchard, though it migl not be necessary to do more than horse-hoe it on or twice in season, so as to maintain a loose surfa and prevent cracking. It was quite open to discussi whether even cherry orchards should not be dealt wi in this way, with crops and bush fruit between the tree For some years he had been watching a cherry orcha formed in this way. At first it was simply kept clea and after a year or two it seemed quite at a stan still. Then the whole ground was trenched by han and the results were marvellous. The trees we planted eight years ago, and now they had heads from 12 to 15 feet in diameter, and a few days sin they were literally one mass of flowers. The questi of packing was very important. The Norman growers sent over large quantities of plums packed small boxes, holding from 6 to 12 lbs. The fr came over in splendid condition, and the consum could buy a box and take it home without any di turbance, and use the fruit as required. Wh plums were sent to market in sieves, they got shak considerably on the journey; then when the retail got them home, he turned them out on to t counter, shovelled them up into the scale, turn them out again into a paper-bag or bask and by the time they reached the customer's hou they had been so knocked about that unless us immediately they would be spoiled. He was som times told that the cost of boxes was prohibitive, b that could hardly be so, seeing that the Gre Eastern Railway Company supplied boxes at fro ½d. to 5d., the larger ones being big enough to ho 60 lbs. At any rate, the choicer kinds of fruit shou be packed in this way. The renovation of o orchards was another point of importance, but th need not always be destroyed; he had seen orchar which seemed going to decay, by proper care broug into a highly fruitful condition. He knew a gentl man who had an orchard consisting chiefly Blenheim oranges which were said to be quite wo out, but by opening out a space between the row trenching, and supplying with farmyard and artifici manure, the trees took a new lease of life, and we now vigorous and fruitful.

Mr. E. D. Till thanked Sir Owen Burne for h remarks on Mr. Bunyard's reference to cider-makin and he remembered that when Mr. Radcliffe-Cool read a paper on cider before the Society, the Chai man, Sir W. T. Thiselton-Dyer, was also sympathet on the same subject. He would like to state his ov experience. In 1895 there was an abnormal crop apples in Kent, and he urged the Technical Educati Committee of the Kent County Council to make e periments with a view to instructing Kentish peop as to cider-making. They declined, but as a gl crop is not too frequent, he urged two Scotchme

farmers at Swanley, to get an expert from Hereford, erect a press, and as apples were plentiful they made 5,000 gallons that season. In a "glut" year liquid storage is the best way of saving a crop and relieving a glutted market of fruit. Something like 40,000 gallons have been made at Swanley since that experiment, and it is commercially successful. There is no difficulty in selling it. It contains a low per-centage of alcohol, $2\frac{1}{2}$ and 3 per cent., and although cider from Kent fruit is different in character from that of the West country, it is not deficient in fine quality and flavour. As to keeping properties, he had been lately drinking good cider, made in 1895-1896 from local fruit. In the Weald of Kent they have lost the true art of cider-making; they put sugar in it, which is a great mistake. The French were paying more and more attention to the manufacture of cider. Mr. Radcliffe Cooke had said he knew nothing for agriculturists which offered such an unlimited and profitable field as cider-making. Mr. Cooke's advocacy of cider, and specially in the interests of his own county, Hereford, had led to his being called the "great De-*cider*-atum." He would like to say that Mr. Bunyard had not referred to poultry keeping in orchards, but he thought it was a valuable and profitable adjunct, and he might mention that the production of poultry and eggs now was equal in value to the value of our wheat crop, and still admitted of immense extension.

Mr. D. LOUIS said the washing of fruit trees with poisonous materials had been practised for the last 50 years, and it was constantly done in France and elsewhere, as well as in England. He did not know of any recorded case in which any accident had arisen therefrom. In connection with artificial manures, he was pleased to hear Mr. Berry's remarks; he had been advocating it in Kent for some years, both because it was more efficient, and on account of the saving in carriage. But these things were adjuncts, not substitutes entirely for farmyard manure, and it was necessary that the right material should be applied at the right time and in the right way, otherwise it might be injurious. He lately had an interesting example of that on some thin soil in South Kent, just over the chalk. It had been dressed persistently with superphosphate, with very bad results; but when he saw the character of the vegetation he recognised that the soil was acid, and advised the use of basic phosphate. That was put down, and the result was an entire change in the appearance of the place.

Mr. BUNYARD, in reply, said he strongly recommended that all new orchards should be raised on arable land, except for cherries, for which he could not advise that course. It was true they did well under it, but if there came a severe frost—anything below 24° below freezing—the trees would be completely spoiled; and not only that, but where the ground was very well manured, the cherry trees ran away altogether. He was called in to advise at a place in Gloucestershire, where they had manured the trees highly, and they made enormous growth, 6 feet in a year, but when they got a hard frost, the trees were completely spoiled. To farm a good cherry orchard, you must let it go on very slowly. With regard to renovation, if you had good sorts, by all means go in for it, but it was useless to take the trouble if the sort of fruit was not good enough to pay for it. With regard to spraying, he had to be very careful what he said. If he advised people to do this, it might be done carelessly, and very grave results might ensue. He knew of a case where a man washed his apple trees with London purple, and some of it fell on the gooseberries, resulting in a vast amount of illness. It was a good thing to use where people were sufficiently careful. A man once said to him, "I never tell people to do it, but I do it myself;" and that was sometimes his position.

The CHAIRMAN then proposed a vote of thanks to Mr. Bunyard, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

THE SIBERIAN RAILWAY.

The *Economist*, of May 6, publishes a letter from its St. Petersburg correspondent giving some particulars respecting the above.

"On May 19, 1891, the present Emperor laid the foundation of the new railway in Vladivostok. The railway had to be built on account of the State, and its direction as at first fixed from Vladivostok covered a route of about 4,740 English miles. Later on, as is commonly known, the Russo-Chinese Bank made an agreement with the Chinese Government as to the construction of a railway through Manchuria. This railway has been called the 'Eastern Chinese Railway,' and will connect Vladivostok with the Great Siberian Railway, thus shortening the distance that was at first projected. As now projected, the system will embrace the following lines:—

	Length in English miles.
Western Siberian Railway	888
Central Siberian Railway	1,149
Transbaikal Railway	737
Eastern Chinese Railway, through Manchuria......................	1,000
Ussuri Railway to Vladivostock	141
Total rail	3,958

"The Central Siberian Railway leads to the Baikal lake, which will have to be crossed by trains in a special steamer received from England. The railway around the Baikal lake will be built later on.

"In addition to the above-named lines, there have been constructed in Siberia three branch lines, the aggregate length of which is about 700 miles.

"Since the opening of the traffic on the Western Siberian Railway and, later on, the Central Siberian, the number of passengers and the quantities of goods transported by these roads were as follows:—

Western Siberian Railway.

	Number of passengers.	Tons at 2,240 lbs. of goods carried.
1898 ..	350,000 ..	483,870
1897 ..	236,000 ..	341,774
1896 ..	160,000 ..	169,355
1895 ..	.. ..	53,226

Central Siberian Railway.

	Number of passengers.	Tons at 2,240 lbs. of goods carried.
1898 ..	300,000 ..	177,420
1897 ..	177,000 ..	87,000
1896 ..	14,700 ..	16,339
1895 ..	.. ..	..

"In four years from the opening of the traffic on the Western Siberian Railway the quantities of goods carried rose from 53,000 tons to 484,000 tons; the number of passengers has also increased considerably, and continues to rise. The Central Siberian road, also, which was not quite ready at the end of last year, shows a considerable expanse of traffic, and when the whole line to Irkutsk is in good working order there is little doubt that the traffic will increase in a great degree.

"The results of the working of the Siberian railways for the 11 months of each of the last two years were:—

	English miles. 1898.	English miles. 1897.
Length of worked sections of the Western and Central Siberian railways	1,425	888
	£	£
Total receipts in 11 months ..	665,151	515,451
Receipts per mile	467	580

"The decrease in the mileage revenue can be explained by the fact that the Central Siberian Railway, until December 1, 1898, had only partly worked, the opening of it all the way from Obi to Irkutsk (1,149 miles) having taken place but lately.

"As it was expected that Siberia would export wheat, and in order to give a cheaper outlet to this produce, it was decided to connect the Ural Railway (Perm-Tiumen) with the Siberian in Tscheliabinsk, prolonging the Ural Railway from Perm to Kotlas, on the Dwina, thus creating a second route for the Siberian produce, *viâ* Archangel. Both roads are at present open for traffic.

"A third outlet for Siberian produce would be the Kara Sea. Some exports *viâ* the Obi and the Yenissei have been effected for the last few years, but as Siberia is also going to be put under a protection *régime*, it is hardly possible that ships should come in to ballast to the Obi and Yenissei, as the cheap Siberian products could not pay the high freights for both ways. Although coal and salt are allowed to be imported free of duty, Siberia is herself rich in these articles, and does not want them (that is the reason why coal and salt have been allowed to be imported free of duty), salt being very abundant in many places in Siberia.

"Siberia is rich in minerals of all kinds, as also in gold; but until now all the production is carried on in the same way as it was some 100 years ago. It is to be hoped that the railway will bring new life into this business.

"Some parts of Siberia are very suitable for agricultural purposes, and now that they are connected with European Russia by rail, there is a wave of immigrants moving to Siberia.

"As it is clear at present to everyone that the traffic on the Siberian railways will be considerable, it has been decided by the Government to replace the 16·2 lb. rails by new ones weighing 21·6 lbs. to the foot. Whilst the first calculation was made for a traffic of three pairs of trains, now the railways are going to be adapted for the service of at least eight pairs of trains.

"The distance from Tscheliabinsk to St. Petersburg per rail is 1,724 English miles; to Riga, 1,92[illegible] English miles; to Libau, 2,037 English miles; to Koenigsberg, 2,087 English miles. If we add to these distances the length of the Siberian and Manchurian railways, say about 4,000 English miles, we find that the whole distance will be a very long one, and as the railway tariff from Vladivostok to one of the Baltic ports could hardly be taken at less than 8s. to 10s. per cwt. (of 112 lbs. English), the possibility of a transit traffic of Chinese or Japanese goods to Western Europe, or of English and German goods to Japan and China, is open to grave doubt, the sea freight from Chinese and Japanese ports to Europe being much lower. But whilst there is this doubt as to the possibility of a transit traffic of goods, it is thought that agriculture and mining in Siberia—and later on, industries—will develop very quickly, and give the railway plenty of work. Especially it would be so if Siberia could have Free-trade."

CLOTH PRESSING BY ELECTRICITY.

At a recent meeting of the Industrial Society of Elbeuf, a report was made by M. Ch. Mouchel, on a new process invented by M. Chedville, which is known as the "electro-calidor" process, and consists of pressing cloth by means of boards heated by electricity. A special committee, appointed for the purpose, examined the manufacture and operation of the press boards. The result is declared to be most satisfactory, and the report, according to the United States Consul at Roubaix, is as follows:—The body of the press board is composed of asbestos paste covered by a netting of German silver. This is again covered by paper pulp, which gives a pliable surfac

without materially increasing the thickness of the press board, which measures from two to four millimetres (·071 to ·157 inch). The first experiments were made by applying the electric current through holes pierced in the portion of the board projecting beyond the cloth. Experience, however, has led to the adoption of press boards with a trapezoid projection, of which the two obtuse angles are covered with copper. Spring clips provided with a metal connection and attached to a pliable conductor serve to transmit the electric current to the copper - covered corners of the boards, when the press is arranged for work. The electric press boards are used in the following manner. On a plate of sheet iron is placed a piece of cloth, between the folds of which are placed at equal distances three electric press boards; then there is another plate of sheet iron, another piece of cloth, and so on, until the press is full. An ordinary press holds eight pieces, the folds of the cloth being one metre (39·37 inches) wide. One of the largest firms of Elbeuf employ a system of hollow presses, and an iron track, sufficiently long to accommodate ten, communicates with each one of their hydraulic presses. Against the ceiling, and parallel with this track, are arranged two conductors, one positive and one negative. They are placed on either side, and a little beyond the line of the track. Large clips for transmitting the electric current are attached by pliable wires to these conductors. The hollow press is then placed between two of these clips, each of which communicates with a movable vertical distributor. The distributor is a simple grooved rod, the conductor being placed in the groove. Thirty pliable wires, each terminating in a spring clip, hang at an equal distance from this distributor. The clips are readily adjusted to the metal corners of the electric press boards, the positive on one side and the negative on the other. The current is thus established and the proper degree of heat generated, the time necessary varying from three - fourths of an hour to one hour and a half. The required current for a press board measuring one metre (39·37 inches) by 70 centimetres (27·5 inches) is 2 amperes under a pressure of 110 volts. A press of eight pieces, with twenty-four press boards, demands a current of 48 amperes to heat the press, and the amount of electric force expended in one hour and a half is as follows:—$48 \times 110 \times 1·5 =$ 7,920 watts per hour. The mechanical force given a dynamo of 90 per cent. working capacity is 12·5 horse-power. The labour expended in one hour and a half is as follows:—$12·5 \times 1·5 = 18·75$ horse-power per hour. Supposing a consumption of 1·5 kilogrammes of coal per horse-power per hour, the quantity of coal necessary to heat a press may be estimated at about 30 kilogrammes (66 lbs.). Estimating coal at 25 francs (£1) per ton, the maximum cost of heating a press would then be about sevenpence. Comparison being made between the amount of coal required by the new system of pressing and the old—viz., direct heating in a special oven by means of sheet-iron plates interspersed between the folds of the cloth—it is found that the old method is slightly dearer than the new, as the firm referred to above, who used the old system with as little waste as possible, and had thirty presses per day, state that they use at least a ton of coal a day for the heating of their plates, which involves an expenditure of 33 francs (26s. 4d.) for the presses used, or 1·10 francs (10½d.) per press. There is thus an economy of fuel; but the new system has other and more important points of superiority. The first is the perfection of the work. The heating of each press, and even of each piece, can be regulated mathematically, either by varying the number of press boards, or by increasing or diminishing the length of the heating. The cloth is heated slowly and without the inequalities resulting from the old system under which the two ends of each piece were almost in contact with plates heated to 500°. All manufacturers who have employed the new system speak of this point as a great advantage. A second advantage is the extreme cleanliness with which the pressing can be effected. The old style of plates heated in an oven often resulted in soiling the cloth, which is now entirely avoided. Another advantage is the economy in laborious handling necessitated by heating and transporting heavy cast-iron plates. The workshops can also be kept at a lower temperature, more favourable to the health of operators. The heat generated in the folds of the cloth is completely utilised by the new process, and a fraction less is lost by radiation than under the old system of heating by plates. If there is already an electric plant in the establishment (and few modern houses devoted to commerce or manufacture are without one) the expense is reduced. The boards are not costly, and with proper care will last several years. M. Mouchel thinks that the process above described is from all points of view a most important invention, and one which should be generally adopted.

Correspondence.

COAL SUPPLIES.

Professor EDWARD HULL, F.R.S., writes:—Mr. Forster Brown, in quoting so largely from my recent book (*Journal*, April 28, pp. 506-7) has forgotten to give the reference, which is scarcely fair to the book or its author. Perhaps you would therefore supply the defect in your next number. The title is "Our Coal Resources at the close of the Nineteenth Century" (E. and F. N. Spon, 125, Strand).

General Notes.

LIQUID HYDROGEN.—At the annual meeting of the members of the Royal Institution, held on

May 1st, Professor Dewar made a brief reference to the recent scientific work of the Royal Institution, and announced that having obtained liquid hydrogen in considerable quantity he had directly determined its temperature and other physical constants, finding its boiling point to be much lower than was previously supposed—namely, 20 degrees above the zero of absolute temperature, and attaining by exhaustion a temperature of only 15 degrees absolute. Pending the discovery in quantity of some yet lighter gas, there was no means in sight of bridging this gap and reaching the zero point. He also took occasion to warn the public against absurd exaggerations as to the properties of liquid air, which, originating in America, found their way into popular magazines in this country.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

May 17.—"The Law of Trade Marks." By J. E. Evans-Jackson.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

June 1.—"The Port of Calcutta." By Sir Charles Cecil Stevens, K.C.S.I., late Acting Lieutenant-Governor of Bengal. The Earl of Elgin and Kincardine, K.G., G.C.S.I., G.C.I.E., will preside.

Applied Art Section.

Tuesday evenings, at 8 o'clock:—

May 16.—"The Artistic Treatment of Picture Frames." By I. Hunter Donaldson.

May 30.—"The Revival of Tradesmen's Signs." By J. Starkie Gardner, F.G.S.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 15...Surveyors, Savoy-street, Strand, W.C., 8 p.m. Mr. R. M. D. Sanders, "Land Purchase in Ireland."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. H. Statham, "Nature and Architectural Ornament."

Medical, 11, Chandos-street, W., 8 p.m. Annual Oration.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. A. T. Schofield, "The Physical and Mental Attributes of the Sexes."

Tuesday, May 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. I. Hunter Donaldson, "The Artistic Treatment of Picture Frames."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. J. Sollas, "Recent Advances in Geology." (Lecture I.)

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5 p.m. Mr. T. E. Hayward, "Life Tables: their Construction and Practical Uses."

Pathological, 20, Hanover-square, W., 8½ p.m. Annual Meeting.

Photographic, 12, Hanover-square, W., 8 p.m. (Photo-mechanical Meeting.) "Specimens of Work with Irregular-grained Screens," &c.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. E. M. Corner, "The Patellæ of the Divers, Grebes, and Cormorants." 2. Mr. Stanley S. Flower, "Notes on a Second Collection of Reptiles made in the Malay Peninsula and Siam, from November, 1896, to September, 1898, with a list of the Species recorded from those Countries." 3. Mr. G. A. Boulenger, "A Second Contribution to the Ichthyology of Lake Tanganyika."

Wednesday, May 17...SOCIETY OF ARTS, John-street, W.C., 8 p.m. Mr. J. E. Evans-Jackson, "The Law of Trade Marks."

Meteorological, 70, Victoria-street, S.W., 4½ p.m. 1. Mr. H. N. Dixon, "The Mean Temperature of the Surface Waters of the Sea round the British Isles, and its relation to that of the Air." 2. Major-General H. Schaw, "Some Phenomena connected with the Vertical Circulation of the Atmosphere."

Microscopical, 20, Hanover-square, W., 7½ p.m. Exhibition of Pond Life.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Annual Meeting.

United Service Institution, Whitehall, S.W., 3¼ p.m. Captain W. H. James, "Modern Weapons, and their Influence in Tactics and Organisation."

Archæological Association 32, Sackville-street, W., 8 p.m.

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Mr. A. R. Canning, "The Lucknow (N.S.W.) Goldfield." 2. Mr. J. D. Kendall, "The Silver-Lead Deposits of the Slocan, British Columbia." 3. Mr. S. O. Cowper-Coles, "Notes on the Electro-Deposition of Palladium."

Thursday, May 18.. Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. J. J. Dobbie and A. Lauder, "Corydaline" (Part VI.). 2. Messrs. C. F. Cross, E. J. Bevan, and T. Freidberg, "Oxidation of Furfural by Hydrogen Peroxide."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lewis F. Day, "Embroidery." (Lecture III.)

Electrical Engineers (at the House of the Society of Arts), 8 p.m. Discussion on Mr. P. V. McMahon's paper, "Electric Locomotives in Practice, and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design."

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Friday, May 19...Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting, 9 p.m., Lord Bishop of Bristol, "Runic and Ogam Characters and Inscriptions in the British Isles."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, May 20...Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. F. Jacques, "The Music of India and the East, and Its Influence on the Music of Europe." (Lecture I.)

Journal of the Society of Arts.

No. 2,426. Vol. XLVII.

FRIDAY, MAY 19, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, 20th June. The reception will commence at 9 p.m.

The following portions of the Museum will be open:—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery; on the First Floor—the East and West Corridors, and the Lecture Room.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These tickets will be shortly issued. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the *Conversazione*. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary) or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

INDIAN SECTION.

Thursday, May 11, 1899; Colonel GEORGE HERBERT TREVOR, C.S.I., in the chair.

The paper read was "Agrarian Conditions under British and Native Rule: a comparison of the Revenue Systems of British India and Rajputana," by MICHAEL FRANCIS O'DWYER, I.C.S.

The paper and discussion will be printed in the next number of the *Journal*.

APPLIED ART SECTION.

Tuesday, May 16, 1899; Sir JAMES LINTON in the chair.

The paper read was "The Artistic Treatment of Picture Frames," by I. HUNTER DONALDSON.

The paper and discussion will be printed in the *Journal* on the 2nd June next.

Proceedings of the Society.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 17, 1899; JOSEPH G. GORDON, Member of the Council of the Society, in the chair.

The following candidates were balloted for and duly elected members of the Society:—

Chatterjee, Sasi Bhusan, 8, Dixon's-lane, Calcutta.

Cuningham, Sir William John, K.C.S.I., East India United Service Club, 16, St, James's-square, S.W.

Johnston, J. Lawson, Kingswood, Sydenham-hill, S.E.

The paper read was—

THE LAW OF TRADE MARKS.

By J. E. Evans-Jackson.

The subject of "Trade Marks" is not by any means a new one to this Society, and in bringing it once more before the notice of the members I do so with feelings of considerable diffidence, well knowing that the subject has been most ably and exhaustively treated on a number of previous occasions, notably by Sir Henry Trueman Wood, some 25 years ago, and by Mr. Edmund Johnson in 1881, and by other well-known authorities. At the same time, I cannot disguise from myself the fact that when these gentlemen dealt with the subject they did so under conditions differing very widely from those which prevail at the present time. The first-named gentleman read his

paper when the first Act was, so to speak, in the chrysalis state, and the latter after some five years' experience of its working. Since that date the subject, and also the commercial value of trade marks, have advanced to an enormous extent, and it is now felt by the great bulk of the manufacturers and merchants of this country—owners of trade marks—that some amendment of the existing law is absolutely necessary if the trade of the country is not to be curbed and weighed down by vexatious restrictions, which may possibly at one time have been advisable and salutary, but have now, by the expansion of trade methods and foreign competition, become irksome and dangerous.

It is for this reason that I have thought it advisable to bring the matter once more prominently before this society, in the hope that some assistance may be forthcoming to further the scheme for an amending Act, which, as a matter of fact, the London Chamber of Commerce, after very mature consideration, has decided to promote, and I do not think it would be outside the scope of this society's work were it to form a committee, to gather and put into form the views and requirements of the trading community on this subject.

I do not think that I am exaggerating when I say that for years past the practice which has prevailed at the Patent-office relating to word marks has been one in which confusion has predominated to an enormous extent, and this state of affairs has arisen from an apparent inability to arrive at anything like a consistent or logical definition of the sub-section of the Act as to what constitutes a "word trade mark."

The decisions in the law courts have been so conflicting that it would be somewhat surprising if the officials at the Patent-office had been able to adopt any consistent line or theory upon which to act when dealing with the applications before them. This fact does not, however, entirely or satisfactorily explain many of the decisions of the Comptroller-General, and I think you will agree with me that this is so when I say that it is within my own knowledge that when a few months ago an application was made to register the word "Jessamine" for soap—this application was refused on the ground that it was a geographical term. The attention of the learned Registrar was drawn to the fact that the Court of Appeal had recently decided that the word "Magnolia" was not a geographical term within the meaning of the Act, notwithstanding that there is a number of places called "Magnolia." The Registrar, acting for the Comptroller, refused, however, to follow the ruling of the Court of Appeal, and refused the application for the word "Jessamine." Within a few weeks a similar application for the registration of the same word "Jessamine," was made by another firm for tobacco, and on this occasion the mark was accepted and registered. I do not profess to say whether or no the word is a word capable of registration under the provisions of the present Act, but I do submit that the Registrar was absolutely wrong in at least one of his decisions in dealing with this word. On the question as to whether such a word should be protected there ought to be no doubt, and the statute should be plain enough to make such a point quite clear.

Looking back we find that until 1875 there was no statute law regulating or providing for the special protection of trade marks, and up to that date trade mark owners had perforce to rely on the common law for any protection they might require against fraudulent infringements.

I think I may fairly say that for some 35 years, or thereabouts, before the passing of the first Act, the courts had recognised the right of property in, and exercised their authority to grant injunctions against the wrongful use of trade marks. The first leading case on this point is that of Millington *v.* Fox, in which Lord Cottenham decided that the defendant could be restrained, notwithstanding that the infringement might have been due to ignorance, fraud being entirely absent. This, so far as I am aware, is the first case in which actual vested property in a trade mark is recognised, and it is quite clear that since that date this right has never been disputed. Neither will it, I think, be disputed that it was from the establishment of this right and from the subsequent varying decisions in the courts there arose the imperative necessity for an enactment for the purpose of more clearly defining such rights, and for the establishment of a register, or record of ownership. This resulted in the Act of 1875, which provides, *inter alia*, that a trade mark must be registered for a particular class of goods, and that registration, as first proprietor, is *primâ facie* evidence of the right to the exclusive use of such trade mark against all comers, and that undisturbed possession for five years is conclusive evidence of the right to a sole property in the said mark.

A trade mark is defined in the Act as follows:—

"For the purpose of this Act, a Trade Mark consists of one or more of the following essential particulars; that is to say—

"A name of an individual or firm printed, impressed, or woven in some particular and distinctive manner; or,

"A written signature or copy of a written signature of an individual or firm; or,

"A distinctive device, mark, heading, label, or ticket;

—and there may be added to any one or more of the said particulars any letters, words, or figures, or combination of letters, words, or figures; also,

"Any special and distinctive word or words or combination of figures or letters used as a trade mark before the passing of this Act may be registered as such under this Act."

The Registry was opened on January 1st, 1876, under the able management of Mr. (now Sir) H. Reader Lack. The classification of merchandise under 50 heads at that time adopted still remains in force, notwithstanding that it has repeatedly been shown how necessary it is that, in many respects, this classification should be altered; for instance, a manufacturer dealing only in soap must register his mark in, at least, four different classes if he desire to have the sole use of such mark for soap.

The Act of 1875 was followed by an unimportant amending Act in 1877, but it was not until 1883 that any further legislation took place, although, as was speedily discovered, the Act of 1875 contained one great defect in that it did not provide for the registration or protection of word marks other than those which had been in actual use before the 13th of August, 1875. The greatest dissatisfaction resulted from this, and various tactics were adopted by applicants for the registration of new word marks. In many cases it was alleged, contrary to the fact, that the marks had been in use before the passing of the Act; in other cases trivial designs were added to the word and registration obtained for the word in conjunction with such designs which it was not intended to use. This unsatisfactory state of affairs existed until 1883, when a new definition of a trade mark was adopted, as will be seen from a perusal of Sec. 64 of the 1883 Act:—

1. "For the purposes of this Act, a trade mark must consist of or contain at least one of the followinng essential particulars:—(*a*) A name of an individual or firm printed, impressed, or woven in some particular and distinctive manner; or (*b*) a written signature or copy of a written signature of the individual or firm applying for registration thereof as a trade mark; or (3) a distinctive mark, brand, heading, label, ticket, or fancy word or words not in use.

2. "There may be added to any one or more of these particulars, any letters, words, or figures, or combination of letters, words, or figures, or of any of them.

3. "Provided that any special and distinctive word or words, letter, figure, or combination of letters or figures, or of letters and figures used as a trade mark before the thirteenth day of August, one thousand eight hundred and seventy-five, may be registered as a trade mark under this part of this Act."

Thus, to the clamour from all quarters for some right to register and obtain protection for word marks, the Legislature made the concession that an applicant could register—"A fancy word not in common use."

If the framers of this definition of a trade mark had with intent determined to use a word which must necessarily lead to litigation, they could not have adopted a better word for their purpose than "fancy." What is a fancy word? There was nothing in the Act to indicate what was meant by the term, and nothing whatever to guide those who were interested in knowing. The word, according to the dictionary, has twenty meanings, but not one of these various meanings relates to words. I fancy a lawyer was at the bottom of that sub-section, and he must have fancied, and rightly too, that a fruitful crop of law suits would result, for such was the case. Many definitions of "a fancy word not in common use" were given, and one of the clearest is that of Lord Justice Lopes, who laid it down that the following conditions were necessary in order that a word should come within the meaning of the term.

"It must be obviously meaningless as applied to the article in question; it must be fanciful in its application to the article to which it is applied, in the sense of being so obviously and notoriously inappropriate as to be neither deceptive nor descriptive, nor calculated to suggest deception or description; and, further, it must have an innate and inherent character of fancifulness, which must not depend on evidence, and cannot be supported by evidence to show, that in fact it is neither deceptive nor descriptive, or calculated to be deceptive or descriptive."

Amongst the words which the courts decided

did not comply with this condition, and consequently were not fancy words, are :—"John Bull," for beer; "Sanitas," disinfectants; "Hand Grenade," fire extinguishers; "Gem," guns; "Rokoko," cotton goods; "Compactum," umbrellas; "Carnival," cigarettes; "Melrose," hair restorer; "Tower," tea; "Emollio," toilet cream; whilst amongst those words which have been held to be fancy words, and capable of registration, are :—"Oomoo," wine; "Alpine," embroidery, afterwards reversed; "Bovril," preparation of beef.

Take the last as an example. Does the word "Bovril" fall within Lord Justice Lopes' definition of the term fancy word? I cannot think it does, and when we remember that such words as "Invincible" for lawn mowers; "Perfect," furniture; "Fir Tree Oil," insectisides; "Japanese," blacklead; "Walkinease," boots; "Standard," oil wicks; "National," boots; "Artisan," stoves; "Siveroid," metallic alloy; "Tip-top," pipes; "Domestic," tea; "The Vets," horse powders; "The Club," matches; "Universal," kneading machines; "Reliance," soap; "Perfection," soap; and hundreds of others of a similar nature were registered without protest at the Patent-office, it is clear that there was something wrong somewhere, for these marks certainly do not fall within the definition of Lord Justice Lopes. There are to-day numbers of word marks on the register that do not nearly comply with the precedent conditions as defined by the courts, and the owners of hundreds of such marks are undoubtedly living in a fool's paradise, from which they may emerge with the inevitable notice of motion to rectify the register. The hardship which is entailed by this condition of things is apparent when we consider that a man may without any objection at the Patent Office register a trade mark, spend thousands of pounds on making it known far and wide, only to find that the courts will expunge the same from the register and deprive the owner of any rights he may have possessed or fancied he possessed.

The restrictions placed upon the registration of word marks by the cramped definition of a "fancy word" rendered it almost impossible to obtain word marks at all, or having obtained them, to be at all sure that the courts would regard them with any respect or allow them to remain on the register. This resulted in a renewed agitation for fresh legislation of a nature which would widen the definition of a trade mark, so as to meet the well-known requirements of commerce.

In response to this agitation, Parliament, in the Act of 1888, substituted for "fancy word" or words not in common "use," the following :—(*d*) "An invented word or invented words, or (*e*) a word or words having no reference to the character or quality of the goods and not being a geographical name."

It is quite certain that the Legislature intended a much wider and more liberal construction to be placed on the provision of the Act of 1883 than the law courts thought advisable, and the very restrictive and almost prohibitive construction adopted by the courts had a disappointing and exasperating effect on the trading community which was thus hampered and absolutely injured in business. This feeling was to a great extent removed when the Act of 1888 came in force, and it was felt by those most interested that "the morning of our discontent" was gone, and this, no doubt, would have been so, and the trade mark owners of this country would have secured that which the Legislature most certainly intended them to have if the courts had adopted a more liberal and reasonable construction of the new terms. Instead of doing so, however, they followed the same course with reference to the provisions of the Act of 1888 as they had previously adopted towards the provisions of the Act of 1883, and placed the most restrictive and, at the same, inconsistent construction on the new terms. This caused, as was natural, a feeling of renewed irritation within the commercial community, while the then existing muddle has become a more bewildering maze of contradictions and absurdities, and the demand for a new Bill, such as that which is being promoted by the London Chamber of Commerce, will, I am sure, be regarded by all reasonable men as well founded and justified in the highest degree.

Having thus briefly dealt with the history of the subject up to this date, I will endeavour to deal with some of the points which I think call for attention.

In the first place, I think it would be to the advantage of all concerned if the Trade Marks-office were separated from the Patent-office, with the Registrar as sole responsible chief. This would not involve a removal from the present premises, but would enable applicants and their representatives to present their arguments at hearings to the head of the department, instead of, as is now the practice, to the second in command, viz., the Registrar,

who, when he is in doubt, terminates the hearing by saying that he will consult the Comptroller, and from the invariable result of such consultations it is reasonable to suppose that the views of the Registrar, rather than those of the applicant, are most prominently presented to the Comptroller.

Further, in an appeal from the decision of the Comptroller, which some few months ago was before the Court of Appeal, the Attorney-General repudiated the statement that the Comptroller had done such and such a thing, asserting that it was the Registrar who had done so, notwithstanding that all the documents bore at the foot the name of the Comptroller. That is, to say the least of it, unsatisfactory, and I submit that there is no occasion for a "buffer state" between the applicant and the head of the Trade Marks-office. For this reason, I suggest that the next Act should deal fully with the subject of trade marks alone, and should repeal all that portion of the Acts 1883-1888, dealing with trade marks, and I would point out that this necessary alteration would not involve one shilling additional cost.

The next point, and by far the most important one that I desire to submit, is the question of word marks. The commercial community of this country demands, and I think is justified in demanding, that a much wider range of words shall be available for registration, and obtain legal protection than the law as now defined allows, and that the section dealing with the subject shall be drafted so clearly and precisely that it will be out of the power of the courts to stifle the efforts of the promoters of such legislation. Word marks are at present refused on the ground that they are either descriptive of the goods—that they are geographical or pseudo-geographical terms—or that they are surnames. I see no reason, and I submit that there is absolutely no valid reason why a manufacturer should not be able to register any word, provided that it can be shown that such word has never been used by any other person for similar goods, and that it infringes no existing rights, and provided that it is not obviously descriptive of the goods themselves, although to some extent it may indicate somewhat of the character of the goods, or purpose for which such goods are to be used, for instance, "Pepsalia," "Somatose," "Vi-Cocoa," "Lactopeptine," all of which, more or less, indicate something of the nature of the goods to which they are applied. The word "Vi-Cocoa" is now registered, but between the period of the first application and the actual registration some two or three years elapsed, during which period an enterprising German appropriated this name to himself, and registered it in Germany, to the damage of the English company, and I would here point out that one of the great hardships inflicted by the refusal to register words of this nature in this country is that the owner is unable to obtain protection in many foreign countries, where, as a condition precedent to registration, it is necessary to produce a certificate, showing that the mark is registered in the country of origin. Now, as a matter of fact, there are hundreds of marks in use here of great value, and to which the owners have the sole right to the exclusive use thereof under the common laws of the country, and any infringement of the same would instantly be repressed by the courts. Surely there can be no harm in registering such marks, and there is urgent reason to do so when it is remembered that the owner is cut off from protection abroad until he is registered here.

Then, as to the geographical objection, it is surely very absurd to say that a trader shall not use or be able to obtain protection for such words as "Sunflower," "Eureka," "Blackbird," "White Horse," "Elephant," "North Pole," and hundreds of similar words, because forsooth they are geographical names. It is true that the Court of Appeal has decided that the word "Magnolia" cannot be refused registration on the ground alone that it is geographical, but it is also true, as I said a short time ago, that the Registrar, acting for the Comptroller, refuses to be bound by, and to follow that dictum; hence I submit the necessity for some amendment.

Again (while, as a fact, the Act says nothing about surnames), words which, while having one obvious meaning to the general public, are rejected on the ground that they are surnames, and, consequently, not capable of registration. Under this head such words as "Swan," "Bull," "Partridge," "Badger," "Throstle," "Crow," and many others, are refused registration.

There surely can be no reason why a manufacturer, having adopted the device of a swan to denote his goods, should in registration be compelled to disclaim any right to the exclusive use of the words "Swan Brand," words by which the public know the goods in ques-

tion, and words which the public use in asking for such goods.

And, while speaking of names, I would for a moment draw attention to the fact that it is provided in the existing Acts that a trade mark may consist of:—

(*a*) "A name of an individual or firm printed, impressed, or woven in some particular and distinctive manner."

Now it appears to me to be clear that this was intended by the Legislature to provide a means whereby a person or a firm might adopt his or their name as a trade mark, provided that it was represented in so unique a manner as to render it easily distinguishable by the ordinary public from any other name of a similar kind. But as a fact this provision is entirely disregarded, and is for all practical purposes a dead letter. Why it should be so is somewhat difficult to understand.

The next provision is:—(*b*) "A written signature or copy of a written signature of *the* individual or firm applying for registration thereof as a trade mark."

This provision is in my opinion too restrictive and works harshly on a certain class of the trading community. It is well known that there are number of persons who succeed to businesses which have been carried on for years under some other name. These individuals continue to carry on the business under the name of their predecessor and adopt his signature, thus John Brown might succeed to a business which had been carried on under the name of Jones, Brown, and Co., and to change that title or signature would be detrimental, but this gentleman could not under this provision register the signature of Jones, Brown, and Co., because although it is the signature he uses in his business it is not his own signature as defined in the Act. Again, a limited liability company really has no signature, and I submit that it would only be equitable to provide in such a case that the seal of such company should be registerable.

Coming to the question of disclaimers as provided under Sub-section 2 of Section 64, I think it is important that any such disclaimer made under this provision should be limited so that the applicant does not thereby prejudice any common law rights which he may have in the subject matter to be disclaimed, and it ought to be clearly set forth in the Act that any such disclaimer is made simply for the purpose of the registration, and is operative only in so far as it limits the rights of the applicant under the registration itself. I do not think that any objection can be taken to some such provision as this; and, as a matter of fact, the courts of Scotland have decided in a case recently before them that the applicant had not, by disclaiming the letters "C.B." in connection with corsets, lost the common law rights which he had prior to the registration in question.

Another point which I think requires to be dealt with is the question of costs in an opposition. At present the only power which the Comptroller possesses in reference to costs is that he can award reasonable costs against an applicant who abandons his application after notice of opposition. He has no power to award costs against an opponent who abandons his opposition. This seems very unfair in view of the fact that if the applicant abandons his application he is liable to pay such costs the Comptroller may adjudge. There seems to be no valid reason why costs in an opposition should not go as in other cases, and follow the result in the ordinary course.

The next point to which I think it wise to draw attention is the absolute discretion vested in the Comptroller in dealing with the registration of trade marks. Under Sec. 62 it is provided that the Comptroller may, on application by or on behalf of any person claiming to be the proprietor of a trade mark, register such trade mark, but there is nothing whatever in the Act to compel him to do so, even with an application which complies with the law, and to which there is no objection. The discretion of the Comptroller should be considerably restricted, and provided that an application is in order, and complies with the conditions set forth in the Act, the discretion of the Comptroller to register should end, and the applicant should be entitled to registration without having to go to court, with the subsequent privilege of paying the Comptroller's costs.

This discretion, at present, enables the Comptroller to adopt a different procedure with different applicants, and, as a matter of fact, certain trade marks which are now applied for in the cotton classes are refused registration, whereas marks exactly similar in all respects, and to which exactly the same objections may be raised, are accepted and registered in other classes. I submit that there ought to be an absolute uniformity in connection with all marks, and in connection with all classes of goods.

The last subject to which I desire to call your attention is the position adopted by the

English office with regard to the International Convention, for the Protection of Industrial Property, signed in Paris in 1883. When the 1883 Act was passed it was contemplated that the English Government would shortly accede to this Convention, and the 103rd Section of the Act pointed to some such action on the part of Her Majesty's Government.

Great Britain became party to the International Convention in 1884, since which date British subjects have been able to claim in all the other contracting States the benefits of this Treaty, but, curiously enough, for some reason which it is not possible to understand, the Convention, so far as relates to trade marks, has been ignored.

The subject of this Convention was first brought before the law courts on the refusal of the Comptroller to register the words, "Syrup of Figs," and an appeal was made from that decision, and tried by Mr. Justice Stirling, who, in giving judgment, used these words :—"Certainly, according to my construction of the Act, it does not afford the means of carrying out the article, and it will, no doubt, be for her Majesty's Government to consider—and, seeing the Attorney-General here, I have no doubt they will consider—what legislative steps ought to be taken to give effect to that article if necessary."

This very broad hint from one of her Majesty's Judges has also been ignored, and no steps have been taken to carry out this important provision of the Convention.

The matter subsequently came before Mr. Justice North in another appeal, in what is known as the "Carter's Little Liver Pill" case, when Mr. Justice North decided that the Convention entered into between Great Britain and the United States could not be enforced in the English Courts, and the Attorney-General—Sir Richard Webster — protested against either the Convention or the Protocol being read, using the following words :—"The Court can only receive their direction by statute, unless there is some right by common law principles, and except for the purpose of inducing your Lordship to take the view of the statute, which I most respectfully submit is not open to you to take, this Convention and Protocol ought not to be read." And further, "If there is any ground for complaint it is a matter for diplomatic interference and cannot be enforced in these courts."

The 4th paragraph of the final Protocol comprises the essence of the whole matter, and it is this which the Patent-office hesitates to carry out, and which, to my mind, ought certainly to be carried out in the form in which it has been adopted in the Convention. The paragraph reads as follows :—

"Paragraph I. of Article VI. is to be understood as meaning that no trade mark shall be excluded from protection in any State of the Union, from the fact alone that it does not satisfy, in regards to the signs composing it, the conditions of the legislation of that State, provided that on this point it comply with the legislation of the country of origin, and that it had been properly registered in said country of origin. With this exception, which relates only to the form of the mark, and under reserve of the provisions of the other Articles of the Convention, the internal legislation of each State remains in force.

"To avoid misconstruction, it is agreed that the use of public armorial bearings and decorations may be considered as being contrary to public order in the sense of the last paragraph of Article VI."

It has been contended that if this provision were properly carried out it would enable applicants from those foreign States where the regulations as to trade marks are very lax to register in this country such words as "bitter" for beer, "black" for coal, and many other common descriptive words. As a matter of fact this is not so, because no applicant under the Convention would be entitled to register any trade mark in Great Britain which by registration would curtail any of the existing rights of British subjects.

The strongest argument employed against the adoption of this construction of the Convention is that it would be manifestly unfair to give foreigners any privileges with regard to registration which are denied to English trade mark owners, but I cannot see that there is anything very unfair in this when it is remembered that foreign countries adopt exactly the same course towards British subjects, and although some foreigner might register a mark in England which would be refused to an English applicant, similarly English firms in foreign countries can register, under the Convention, trade marks which would be refused to the inhabitants of those countries.

I further submit that if this argument has any basis at all, it is rather late in the day to bring it forward, and it ought certainly to have been discovered before the Convention was entered into. I have not yet heard a single argument adduced against the adoption of the provisions of the Convention, which

will, as a matter of fact, bear the light of day. The only objections are really matters of sentiment, and I think, as a matter of common honesty, the Government ought to take some steps to carry out the agreement into which they entered in this respect.

I think the reasons I have adduced are sufficiently reasonable to support the demand for an amendment of the existing law on trade marks; and an amendment of a character in accordance with the just and well-known desires of the whole trading community.

DISCUSSION.

Mr. HAYES FISHER congratulated Mr. Evans-Jackson on the manner in which he had treated his subject. The paper dealt mainly with word marks, which were the principal feature in modern registration. It was only within recent years that such marks had been allowed at all, the original idea being a design or "mark" of some kind. Objections to such words as "Blackbird," because it was geographical, or "Rainbow," because it was a surname, certainly seemed hypercritical. With regard to the convention, he thought that England rather rushed into the matter with the idea of bringing about a millennium in the protection of industrial property. A universal trade mark would be a very good thing, and they would all like to see every one's property protected; but it was not such an easy matter. At the same time it was a pity that legislation should stop the initial efforts of a foreigner endeavouring to obtain protection here. Many of the points referred to were dealt with in the new Bill in a very thorough manner, and great credit was due to Mr. Evans-Jackson, who had given a great deal of time and labour to the committee which drafted the Bill. Many eminent counsel had also assisted, and it had been taken up by the London Chamber of Commerce and influential members of Parliament, so he believed it would do a great deal to distinguish between the goods of rival traders, and to diminish that constant litigation which was a curse to a commerce-loving nation.

Mr. F. P. M. SCHILLER said, however honest and comprehensive an Act of Parliament might be, he did not think the day had arrived when lawyers would not find some loophole by means of which a defence might be set up by those traders who were not as honest as could be wished. An almost inevitable blemish in trade mark law was that the Judge who tried the case had to consider not what he alone thought of the likeness between two marks, but what the ordinary purchaser of the article might be led to believe, and it was not easy to investigate the working of another person's mind. It was easy enough for the ordinary person to tell whether the article offered him, whether Day and Martin's blacking, or some one's sugar, was what he wanted, or something else, but the difficulty was to gauge the amount of resemblance which would be necessary in the get-up of the so-called infringing article to deceive some one else. The Judge, who had no particular skill in the matter, had to judge what was in the mind of the retailer, and he did not see how that difficulty could be removed by legislation. One knew from reports of cases that, as had been said in one case, there was always the witness who proved the deception; the little girl who could not read or write, who was sent to fetch a particular article, and the dishonest trader deceived her. To a certain extent, the remark was meant to be satirical, but there was a certain amount of truth at the bottom of it, and perhaps some Judges did not spread their net wide enough. It might be difficult, in many cases, to properly gauge the likelihood of one article being mistaken for another, but, after all, the object of a trade mark was that the public might know where an article came from, and have the guarantee of quality which that secured. Formerly you had to prove that some one had actually been deceived, but now likelihood of deception was sufficient. A point which required careful consideration was the intention of the trader, because many people relied absolutely on what he told them, and he was convinced that an enormous number of frauds were committed which were never discovered. A purchaser who asked for a particular article was given another, and told by the shopman it was the same thing, and thus both he and the manufacturer were defrauded. He thought in such cases a heavy fine should be inflicted, such as was imposed under the Merchandise Marks Act. If a dishonest tradesman knew that if his offence were discovered he ran the risk of losing all the profit he had made by his unfair dealing, he would be much less inclined to go in for it. The great difficulty at present was to tell a client whether his proposed mark was an infringement of some one else's, and there the personal element of the tribunal was very important; one Judge would see a likeness where another did not. He did not think the disclaimer clause was very beneficial to trade interests. A man might produce a design which entirely distinguished his goods from anybody else's, and yet he might have to disclaim the bulk of the design. He might register a label for which he could claim no exclusive right, because there was no design on it which fell within the definition of the Act. He could only register the label as a whole, and he might have to disclaim the very portion which made it familiar to the public. It might be a label which offered a large reward for something, which was not uncommon. That printed matter would have to be disclaimed, though it was the very thing which caught the eye and enabled the article to be identified; in other cases it might be a name. He could not see the utility of the disclaimer

clause. Either a label or mark was distinctive, or it was not. If it was not it could not be on the register, and if it was it seemed unfair that it should be shorn of a portion of the device which went to make up its distinctiveness. He could not agree with Mr. Evans-Jackson as to the convention, that, if he might so put it, what was sauce for the goose was sauce for the gander; he must say that his sympathies were with the Attorney-General on that point. It was all very well to say, I offer you my house, and, therefore, I have a right to take yours; that seemed very fair; but if one house was in a slum in Whitechapel, and the other in Grosvenor-square, it was not fair at all. The same principle applied to trade marks; it depended entirely on what were the requirements of the law affecting trade marks in the different countries. If in France or Germany you could register descriptive words referring to the quality of the goods, it was obvious that when the goods came over to England they would get an advantage which English goods did not enjoy, because our law was more stringent. Until some arrangement could be made by which trade mark law could be reduced to something like uniformity, the convention would only lead to injustice and friction in business.

Mr. J. F. ISELIN agreed with Mr. Evans-Jackson that a better definition was wanted for word marks, and it seemed to him that no reasonable definition existed, except possibly that in force in France and Belgium, by which any word which was in itself distinctive was regarded as a trade mark; but it was very doubtful whether that definition would ever be accepted by Parliament, or by the commercial community. He should be glad to hear the definition that Mr. Evans-Jackson proposed. Another point intimately connected with this was the question of the international Convention. There was no doubt that the present state of affairs was exceedingly unsatisfactory. So long as we were a party to the convention we were committing a breach of faith in not enforcing it; the British Government ought either to withdraw from the convention, or call an assembly of the other Powers, and endeavonr to get it altered if it was objectionable. He believed one reason why the Convention was unsatisfactory, was on account of the diplomatic superstition, according to which all instruments of this character were drawn up in French, and thus terms of French law were used, which were ill adapted for use in England. The result was misunderstanding, such as had occurred in this case, and also in connection with the Berne convention and international copyright. The present state of things was intolerable, and if the Bill referred to only put an end to this very anomalous situation, it would be worth having.

Mr. S. BROMHEAD agreed with Mr. Evans-Jackson that a radical reform in the present law of trade marks was needed; and especially that a better definition should be given of what such marks might consist of. He had often had applications refused for the most trivial reasons. On one occasion he applied to register a bird, and it was refused because there was already on the registry a mark, in one corner of which there was a bird on a tree. In another case the word "Boxa" was refused registration for cigars and cigarettes because there was a registered device of two boxers facing one another in a sparring match. It seemed to him there was an excess of caution about the present Registrar, who, in his intense anxiety not to interfere with the rights of those who were already on the register, unwittingly did serious injustice to those who came forward desirous of registering new ones. He thought it would be exceedingly dangerous to adopt Mr. Schiller's suggestion of fining heavily a tradesman who supplied one article for another. "Caveat emptor" was a good old maxim, and the buyer could always protect himself, and insist on having the article he wanted; it was his own fault if he did not. If he got an article not equal in quality to what he wanted, he had a right to complain, and he would naturally transfer his custom, and that was the natural penalty on the retailer. There were now an enormous number of manufacturers making similar articles, and the retail trader could not keep every brand in stock. He selected one or two of the best for his particular trade, which he could honestly recommend. If he did not keep Day and Martin's blacking, he would recommend something else as equally good; and if the purchaser took it and was satisfied, he did not think the tradesman should be treated as a criminal.

Mr. REGINALD BARKER said he had come across several anomalies in his practice of a similar nature to those which had been mentioned. The Registrar refused "Myrtle Grove" because there was a small town of that name in the United States, and to take a man's name, printed in the form of a monogram, as not being distinctive. The signature of an individual or a firm might be registered; but if the firm was turned into a limited company, and wanted to register the old signature, it was refused. Section 64 provided for the registration of an invented word, and of a word not having any reference to the quality or description of the article. Hitherto the Courts had read the two sections together, but recently it had been decided in the Solio case that a descriptive mark could be registered if it were an invented word. Since that the officials had been taking all sorts of invented words. Such as "Saltine," with a disclaimer of the word salt. These disclaimers were altogether objectionable and misleading; it would be much better to register the entire combination Not every invented word, however, could be used, "Perfecta" being refused because it is Italian for perfect, and "Benaroid" because it suggested Benares. If a mark could not be registered here it could not be protected in foreign countries, which was a great hardship. With regard to classification, again, there seemed room for improvement; cigarettes were in one

class, cigarette papers in another, pipes in a third, and cigar lights in a fourth.

Mr. BROMHEAD wished to add a protest against all dictionary words being refused. He thought Indian or Greek, or obsolete words should be admitted; but they were frequently confronted with a dictionary of some outlandish tongue, and told that a word they wanted to use was found there.

Mr. F. G. UNDERHAY said there were two classes of trade marks, registered and unregistered, and it had been pointed out by Mr. Justice Stirling that the use of the words, "trade mark," was not an offence against the section of the Act which facilitated the use of the words, "registered mark," when there was no registration. The fact that there was a very efficient common law protection for unregistered marks, was a great mitigation of some of the evils pointed out in the paper. The remedy, however, was not quite so wide, the injunction granted was in a more limited form, and the owner had to prove his title. This involved great expense, and after having done it once, it had all to be gone over again in case of another infringer. If that hardship could be removed, the common law remedy would be almost as efficient as that conferred by the Act, and he did not see why the Judge should not be empowered to grant a certificate which would be available in future proceedings. There might then be a list of trade marks which had been established at law, though not registered, and if the rights thus established were not quite so extensive, they would be, in many cases, adequate. He thought also that all words used as marks should be taken in their natural meaning, and not refused because they had been applied to some obscure place somewhere or other, and were thus said to be geographical.

Mr. EVANS-JACKSON, in reply, said there was not much difference between Mr. Fisher and himself. He could not agree with Mr. Schiller that the tradesman should be criminally liable; it would be dangerous, as he would be at the mercy of his assistants if they sold an article which sometimes was not decided to be an infringement without some difficulty, even by a Judge. The onus ought not to be on the retailer, but on the manufacturer, or the man who put the weapon in the hands of the shopkeeper. With regard to the convention, if two men made an agreement to exchange houses they ought to fulfil it, wherever the houses were situated. When a bargain was made it should be adhered to; and his belief was that if individuals repudiated their contracts in the way the British Government had done the Attorney-General would order a prosecution. We had received the consideration, in so far as thousands of British manufacturers had obtained rights abroad, under the convention, which they would not have had unless those countries had believed that Great Britain would carry out her part of the treaty in an honest manner, as she usually did. He should be glad to give Mr. Iseli the definition of a trade mark in the new Bill, thoug he was not altogether responsible for it, and shoul have framed it somewhat differently, but he gave wa to more experienced and eminent men, on conditio that the Bill should be referred to a Select Com mittee, so that experts and other persons intereste might give evidence and suggest alterations. (H then read Clause 3 of the Bill.) It had been suggeste by one gentleman that the officials were over-cautiou but, he thought, they were actuated by a feelin which was the growth of official life, that on the rested the business and trade of the country, that the knew how manufacturers ought to mark their good how merchants should put them on the market, an how the public should ask for them, and that manufacturers would not do as they wanted, the should do without trade marks at all. It was th desire of the schoolmaster to bring up a boy in th way he should go; but he thought the trading com munity were quite capable of getting on without schoolmaster of that class. With regard to the rul of *caveat emptor*, he did not think the whole respons bility should be put on the shoulders of the buye He did not regard an unregistered trade mark as o any value outside the ordinary get-up of a packe You could not take any proceedings on the marl only for passing off, as you could on an imitation of wrapper. If it was only the benefit you got in th country, he should not register anything at all, becau you got as much protection from the common law it was for the purpose of enabling you to secure pro tection abroad. Every man naturally expected h trade to expand; and when he found orders comin in from different parts of the world he said, "Th trade mark is getting valuable; I must register it. The Comptroller said he could not register it, but th Judge would stop any one else using it. That wa what happened in the case of Vi-Cocoa; the Comp troller said it was descriptive, and then he appeale to the Board of Trade. Some little influence wa brought to bear, and ultimately the mark was regis tered; but three years' delay had taken place, durin which a German company took the name, and no had the sole right to it in Germany. If you had a absolute common law right, what objection could ther be to registration; and if the Judge could give certificate, why could not the Registrar? The con vention would not allow the appropriation of th word "Bitter" for beer, if it clashed with any existin right; but if any one wanted to register Black, o Nubian, for coal, and no one had ever used it befor why should it not be done? It interfered with no one and we got something abroad in exchange.

The CHAIRMAN proposed a vote of thanks to Mr Evans-Jackson for his paper, which had dealt in a able manner with a very important subject. It ha also evoked a very useful discussion. The resolu tion was carried unanimously, and the proceeding terminated.

Miscellaneous.

COMMERCIAL EDUCATION IN ENGLAND.*

By Sir Henry Trueman Wood, M.A.

As I am addressing an audience composed mainly of others than my own countrymen, although it is an audience of educational experts, I may perhaps be permitted to preface what I have to say about commercial education in England, by a general sketch intended to indicate the points in which our English system of education—so far as we can be said to have any system—differs from that of our Continental neighbours. My remarks must be understood as referring only to England, not to the other parts of the United Kingdom.

It is only of comparatively late years that the Government has had anything to do with the education of the people. For some centuries back all English education was practically controlled by our two ancient universities—Oxford and Cambridge. They decided what subjects were to be taught, and how they were to be taught. The control they exercised over our English schools was an indirect one, but it was none the less effectual. The schools themselves were, like the universities, independent of Government, or, indeed, of any control. The principal of these are known as "public schools," though the term "public" has of late years also been applied to the public elementary schools. These are nearly all developments of ancient foundations. Winchester, founded in the 14th century, and Westminster in the 16th, grew up under the shadows of great religious houses; Eton was established in the 15th century by the monarch, close to his own palace at Windsor; Harrow, which dates from the 16th century, is the most important example of the most numerous class of all, privately founded local schools—grammar schools as they were generally entitled—which have developed beyond their original founders' intention, and have eventually come to attract boys from all parts of the kingdom.

Of these schools there are, and have long been, a great number of different rank and varying importance. The most important of them have scholarships, which are held by the successful students at the Universities, some of them being associated with special colleges. The best boys from all of them went to the Universities, and the course of study which was most successful at the university was naturally the course of study which was preferred at the school. The *literæ humaniores*, which were the sum total of University education, included only Greek and Latin language and literature, Mathematics and Logic. Science—I have now in my mind the education of but a single generation back—was ignored. The teaching of modern languages was perfunctory in the extreme; the same may be said of history and geography; while even English language and literature were almost entirely neglected.

Now an education modelled on these lines was not ill-suited for professional men—men who went from the University into law, the church, or medicine. But it was by no mean suited, especially when cut short in its early stages, for boys whose future destination was the counting-house or the shop. I do not propose to discuss the vexed question of literary *versus* scientific education, but I should like to be allowed to put on record my own personal belief - that no finer instrument has been devised by the mind of man for mental training than the study of the classical languages; nothing better suited for education in the truest sense, that is the training of the mind to the acquisition of knowledge, and not the provision of information which may be useful in after life to the person who has acquired it in his youth. This, however, is not the question before us. We are not met to consider the training of scholars, but the sort of education best adapted to the requirements of the ordinary man of business, and given under the limitations inevitable in the conditions of the case, that is to say in a very limited period and during the early years of life—intended also not only to train the mind but to provide a means of earning a living. Commercial Education must in fact be a compromise between real education and business training. The more it inclines to the former the better.

With the growth of modern industry and commerce the necessity for a training better suited for the requirements of modern life became more and more evident, and the place was supplied, or partially supplied, by private adventure schools, which undertook to provide the essentials of a commercial education. Of late years also some important middle-class schools have been founded by institutions like the Boys' Public Day Schools Company, and the Girls' Public Day Schools Company, the teaching in which is of a modern if not of a commercial character. The growth also of science had its natural and obvious effect on educational methods. Scientific teaching was introduced at the Universities—it had been practically ignored at Oxford, and recognised at Cambridge only as a department of mathematics. The more important of our public schools introduced what was known as a "modern side," that is to say an alternative course which a boy might take, and in which science, modern languages, and mathematics took the place, to a greater or less extent, of the classical languages. Other schools modified their whole curriculum in a like direction others again almost abandoned the ancient knowledge in favour of the modern. Such, in briefest and baldest summary, is the condition at which our system of secondary education has now arrived.

In the meantime, elementary education in England had been organised and systemised. At the beginning of the century elementary education was im-

* A paper read at the International Congress on Technical Education at Venice, May, 1899.

parted to the children of the peasants and agricultural labourers in village schools, most of which were sadly nefficient. In the towns there were various charitable nstitutions for educating the children of those who were unable to provide education for themselves, and there were also what were known as ragged and parochial schools, which were more or less of the same character as the elementary schools of to-day.

Early in the century, several important societies were established—they were mostly of a religious character—for the improvement of elementary education. By their assistance schools were founded throughout the country. These were maintained by voluntary effort, and so gained their name of voluntary schools, though they received aid from the Government, an annual grant being allotted for the purpose. This grant was first made in 1833. The expenditure of the subsidy was left to the two great educational societies—the National Society and the British and Foreign School Society, and the Government assumed no direct responsibility for the actual efficiency of the aided schools. In 1839, a Committee of the Privy Council was created to regulate the administration of Government grants for education, and this Committee still remains the governing body of our Education Department. The Elementary Education Act of 1870, with later Acts of 1876 and 1880, laid down the principle that sufficient elementary education should be provided for all children of school age, and established a system of School Boards, which Boards were to be and were formed in all districts where such sufficient provision for education did not exist. By a later Act of 1891, education was made gratuitous as well as compulsory. We have, therefore, now two great classes of elementary schools—School Board schools, in which education is free, and Voluntary schools, in which a fee may be charged. Both alike receive Government aid under certain conditions. As a rule, the Voluntary schools are connected with the Church of England or with one or other of the Nonconformist bodies. The Boards, which control the Board Schools, are elected bodies, and the teaching is undenominational.

(To be continued.)

General Notes.

Russian Scholarship.—A Scholarship of at least £40 a year, tenable for two years, will be offered for competition among the members of Caius College, Cambridge, in their second, third, or fourth year of residence, for proficiency in the Russian language. Candidates must be British subjects of British descent who (1) have been educated at a public school in the United Kingdom, or (2) are sons of persons holding appointments abroad in the British Public Service. They must be or have been candidates for a Tripos, and must have attained a creditable position in the Annual College Honours Examinations. The standard of examination for the Scholarship in Russian will be such as may reasonably be expected of candidates who have studied Russian for one year under the University Teacher of Russian. The scholar elected will be required from time to time to pass further tests in Russian. The Scholarship may in certain cases, at the discretion of the Governing Body, be held with another Foundation or an Exhibition.

MEETINGS OF THE SOCIETY.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

June 1.—"The Port of Calcutta." By Sir Charles Cecil Stevens, K.C.S.I., late Acting Lieutenant-Governor of Bengal. The Earl of Elgin and Kincardine, K.G., G.C.S.I., G.C.I.E., will preside.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

May 30.—"The Revival of Tradesmen's Signs." By J. Starkie Gardner, F.G.S.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 22 ... Royal Institution, Albemarle-street, W., 5 p.m. Adjourned General Meeting.

Tuesday, May 23...Royal Institution, Albemarle-street, W. 3 p.m. Professor W. J. Sollas, "Recent Advances in Geology." (Lecture II.)
Photographic, 12, Hanover-square, W., 8 p.m. Mr. Bishop, "Corea."

Wednesday, May 24...Linnean, Burlington-house, W., 3 p.m. Annual Meeting.

Thursday, May 25.. Royal, Burlington-house, W., 3 p.m. Prof. L. C. Miall, "Water Weeds." (Lecture I.)

Friday, May 26...Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting, 9 p.m., Sir William Conway, "Climbs and Explorations in the Andes."
United Service Institution, Whitehall, S.W., 3 p.m. Mr. W. Marshall, "The Importance of Sea Power in the Growth of the Roman Empire, showing the lessons taught to ourselves."
Physical, Chemical Society's Rooms, Burlington-house, 5 p.m. 1. Prof. S. Young and Mr. Rose-Innes, "The Thermal Properties of Normal Pentane" (Part II.). 2. Mr. C. G. Lamb, "The Distribution of Magnetic Induction in a Long Iron Bar."

Saturday, May 27...Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. F. Jacques, "The Music of India and the East, and Its Influence on the Music of Europe." (Lecture II.)

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FRIDAY, MAY 26, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, 20th June. The reception by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman, and other members of the Council, will commence at 9 p.m.

The following portions of the Museum will be open:—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery; on the First Floor—the East and West Corridors.

A selection of music will be performed by the String Band of the Royal Artillery in the Central Hall, and by the Red Hungarian Band in the Bird Gallery, commencing at 9 o'clock.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These tickets will be issued shortly. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the *Conversazione*. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary) or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

The entrance to the Museum is in the Cromwell-road. Carriages must enter the grounds by the east gate and leave by the west gate. The cards must be given up on entering the Museum.

Visitors arriving or leaving by either of the Metropolitan Railways will be allowed the use of the District Company's Subway, which leads from the South Kensington Railway Station direct into the grounds of the Museum.

Fuller particulars as to the musical and other arrangements will be given in the Programmes which will be distributed on the evening.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 11, 1899; Colonel George Herbert Trevor, C.S.I., in the chair.

The Chairman announced that as Mr. O'Dwyer was in India the paper would be read by the Secretary of the Section.

The paper read was—

AGRARIAN CONDITIONS UNDER BRITISH AND NATIVE RULE: A COMPARISON OF THE REVENUE SYSTEMS OF BRITISH INDIA AND RAJPUTANA.

By Michael Francis O'Dwyer, I.C.S.

The heading of this paper opens out a subject too wide to be dealt with adequately without trespassing at great length on the patience of the Society, and too intricate to be treated fully without broader experience than mine. In practice, therefore, I shall confine my remarks to a comparison of a few of the most salient points in the revenue system of the Punjab, the province with which I am most familiar—and of the two Native States of Alwar and Bhartpur in Rajputana, in which I have been conducting the Land Revenue Settlement for the last two years. These two States, of which Alwar is ruled by a Rajput, and Bhartpur by a Jat chief, fringe the south-eastern frontier of the Punjab and the west of the North-West Provinces, marching with the British districts of Gurgaon, Muttra, and Agra. Up to the beginning of the present century their political and revenue history was practically the same as that of the adjoining British districts of the North-West Provinces and the South Punjab, which came under our rule on the capture of Delhi by Lord Lake in 1803. The village communities are modelled on the same pattern, the agriculturists are largely of the same race, and agriculture is carried on under similar conditions.

The contrasts and differences which a comparison of their revenue system with that of the Punjab or North-West Provinces may now reveal is, therefore, mainly due to the difference in the methods pursued during the last century by the native and British administrations. To trace the origin of these divergencies historically would be an interesting but lengthy proceeding; to describe them as they now exist, and strike an observer who had come fresh from the British system of the Punjab, may not be altogether uninstructive.

Alwar and Bhartpur have each a population of about 750,000, or nearly equal to that of an average district of Northern India. This population lives mainly by agriculture, and each State levies, in round figures, about 21 lakhs of rupees a year as land revenue from the agriculturists, this being the chief source of income.

The prosperity of the State and of the agricultural classes is, therefore, bound up closely together, even more so than in British India, where the revenue from land does not amount to more than two-fifths of the annual income, and the well-being and contentment of the people as a whole are mainly dependent on the revenue system pursued.

In Alwar and Bhartpur, like the neighbouring British districts, the unit of the revenue system is the village community. In both States the land is generally in the hands of what may be provisionally called peasant proprietors, grouped according to ancestral descent or historical accident into such communities, each of which is treated by the State as a single entity with a corporate existence. The simplest way of comparing the British and native systems is to fix our attention on these communities, and to examine

(1). Their relative positions with reference to the State, and the relations of the different members to one another.

(2). The relationship of the proprietary body as a whole to the non-proprietary cultivators.

Position of Village Communities in Reference to the State.

As regards this fundamental question, the British and native systems start from the same standpoint, or rather the British Government inherited or adopted the theory of the native powers whom it superseded, viz., that the ultimate ownership of the land vests in the State, and that the State is consequently entitled to receive a share of the produce of the land from the persons who occupy and cultivate it, or arrange for the cultivation. The principle is clearly embodied in Regulation XXXI. of 1803, perhaps the first authoritative legal enunciation on the subject:—"By the ancient law of the country, the ruling power is entitled to a certain proportion of the annual produce of every *bigha* of land." In the Punjab Land Revenue Act of 1871 this principle still finds clearer expression:—"The Government of India is by law entitled to a proportion of the produce of the land of the Punjab to be from time to time fixed by itself."

The most autocratic native ruler could not claim a wider discretion than this. It is in the working of the British and native systems that the divergence is to be seen. This may be considered in two aspects:—

1. The rights which the State has reserved to itself, and those which it has conferred or allowed to develop in the persons actually occupying the land.

2. The liabilities which it enforces in the case of the latter, in the form of land revenue and other claims.

As regards (1), the native system, while it recognised that immemorial custom entitled the occupiers of the soil to the right to hold it without disturbance, and transmit it to their descendants, provided they paid the State a share of the produce, whether fixed in kind or commuted into a cash payment, and whether varying with every harvest or fixed for a term of years, in practice it limited its demand only by the ability of the landholder to pay. No margin of profit was, therefore, left to the non-cultivating owner or occupier, as the State share absorbed all the rent which the latter could claim from the actual cultivator. The tendency of this system, which is, I believe, still traditional in most Native States, was to prevent or arrest the development of a body of proprietors as separate from the actual cultivators, existing on the margin of profit left between what they realised from their tenants and what they actually paid to the State.

The case often arose, and instances are still frequently met with, in which the State, instead of dealing with the village community direct, leased its rights to a farmer or lessee for a fixed sum, the latter having the right to realise direct from the village community, and to appropriate any margin of profit left over after paying the State demand. Such leases are, however, looked on as purely temporary, and give the lessee or farmer no right to oust existing occupiers as long as they maintain

the cultivation and pay their share of the produce. He may, however, settle cultivators to break up waste or take up abandoned land. The position of these lessees appears very analogous to that of the revenue farmers we found in Bengal, who were made into absolute proprietors of the estates which they farmed by the Permanent Settlement of 1793, but I have hardly come across a single instance in these two States in which the lessee was gradually translated into the position of proprietor. Such leases are generally given to individuals in cases where the village refuses to accept revenue liability imposed by the State, or when arrears accumulate against them, or if realisation of the demand by the State authorities becomes difficult, and the State disembarrasses itself of the burden and inconvenience of direct management in favour of a lessee, whose efforts to realise, aided by the stimulus of personal gain, are likely to be more successful. The result of thus making over the village to the tender mercies of a farmer is that the community, after a more or less brief experience of his methods, generally applies to have the lease set aside and offers to accept responsibility itself.

The broad fact, however, remains that in the ordinary Native State which has not come under the influence of the British system, the State demand absorbs all the profits of cultivation or the entire rental, and there is little or no room for the growth of proprietary as apart from cultivating rights. To quote the words of one of the clearest and deepest thinkers on the subject, from Thomason's "Directions to Settlement Officers":—

"So long as the Sovereign was entitled to a portion of the produce of all land, and there was no fixed limit to that portion, practically the Sovereign was so far owner of the land as to be able to exclude all other persons from enjoying any portion of the net produce (*i.e.*, rent). The first step towards the creation of a private proprietary right in the land was to place such a limit on the demand of the Government as would leave to the proprietors a profit, which would constitute a valuable property."

This brings us to the second aspect of the question, viz., the liabilities of the village communities or proprietary bodies to the State. It has already been shown that the British Government took its stand on the ancient usage entitling the State to a share in the produce of all land, and also claimed the right to fix that share itself from time to time. For convenience that share has been fixed in cash either in perpetuity as in the permanently settled districts of Bengal and Madras, or temporarily, for a greater or less term of years, in the remaining territories, and it is the proportion of the produce which the State has from time to time fixed as its share, and the method by which the cash value of that share is assessed, that have so profoundly modified the pre-existing conditions in territories that have come under British rule.

In the districts permanently settled during the administration of Lord Cornwallis, 91 per cent. of the net rental or net produce was taken as the standard of the Government demand, and though the enormous expansion of cultivation and increase of prices within the last century have now made this assessment a feather-weight one, it was, according to our present notions, enormously high at the time, though it was a distinct advance on the old native system, which claimed to appropriate the entire rental.

This system could only be successfully worked as long as the State was content to receive its share in kind, or to appraise the value of the crops of each harvest, and to commute the estimate into a money payment at current rates; so that the demand of each year or harvest varied with the circumstances of the season, and the elasticity thereby secured was a security against the breakdown of the cultivators. Immediately a system of fixed cash assessments is introduced, an attempt to levy the full rental of an average year, in good years and bad alike, must inevitably result (at least in a tract open to great vicissitudes of season) in the collapse or impoverishment of the cultivator, and thus the State in its own interests—if it wishes to secure fixity of payment—must be prepared to forego such a margin of the average rental as will enable the cultivators to meet a bad year. It was, no doubt, partly for this reason, and partly from a desire to fix the landholding classes more permanently in the soil, by giving them a valuable interest in it, that the British Government has gradually reduced the standard of its demand.

Regulations IX. and X. of 1812 for the Bengal Presidency reduced the proportion to five-sixths, but this was only to operate in case of new assessments, the existing demand even where it exceeded that proportion being maintained, unless there were very strong reasons for reduction on other grounds. This continued to be the standard till 1844, when Thomason, in his "Directions to Settlement Officers" of the North-West Provinces, prescribed that the Government should not demand

more than two-thirds of what may be the net produce (*i.e.*, net rental) to the proprietor during the period of settlement. The increasing experience which was being acquired, with the extension of our rule over new territories, was now making it more and more apparent that a judicious limitation of the share demanded by the State was beneficial to the people by acting as a powerful incentive to industry, and thus, in the long run, was advantageous to the State as well. Accordingly, in 1855, we find the proportion still further reduced, and in the instructions for the settlement of the Saharanpur district, the principle was first enunciated that the State share should be limited to 50 per cent., or one-half of the average net assets. The regular settlements of the Punjab proper were based on this proportion, and as the traditional caution of settlement officers, especially when dealing with a tract where cash rents are not general, led them to make liberal allowance for the many varying and uncertain factors involved in ascertaining the money value of rents in kind, we find that the Punjab assessments are relatively much lighter than those of districts which were originally assessed under the earlier standards. My own experience of Punjab districts would lead me to estimate that the State share does not usually exceed from one-third to two-fifths of the net assets or rental; but this, of course, does not include extra cesses, for which another 10 per cent. might be added all round.

The fixing of one-half the net assets or net rental as the limit of the State demand, which has now become so familiar that some people write of it as if it were as old as the Vedas, and part of the immemorial usage of the country, dates back only a generation, and is limited to British India. It has never been adopted by native rulers, though in States where the assessment has been made by British officers or influenced by British ideas, something has been done of recent years to limit the State share. The Maharaja of one of the largest and most progressive States in Rajputana, when asked by me, in the course of conversation, what rights the zamindar possessed, and what share of the net produce the State claimed, seemed astonished that there could be any room for doubt on the point, and at once replied that all rights in the land belonged to him, and that the State share embraced the whole rental.

Of course, in practice the absence of reliable records, and collusion between the zamindars and the revenue officials, often enable the former to evade payment of the full rental, or prevent this from being accurately ascertained. The State which I have referred to has never yet been surveyed, and possesses no reliable village maps or records. The village bodies are at present paying what was once and is still assumed to be the full letting value of the land. Reassessment operations have now been undertaken, and as the people there, as in many other parts of India, have a superstitious horror of their fields being profaned by a measuring chain, the procedure is something as follows. The reassessing officer, accompanied by his satellites and a number of expectant lessees or speculators, enters an estate. The people are asked what advance they are prepared to offer on the existing demand. If they demur, they are informed that their fields will be measured to ascertain the correct area of cultivation and of crops grown, while, at the same time, one of the accommodating speculators offers an advance of a certain sum on condition of being allowed to make his own terms with the cultivators. These frequently eliminate themselves from the dilemma of having their fields surveyed, or being ground under the heel of the revenue-farmer, by offering to pay as much if not more than the latter, and enter into an engagement accordingly for a term of years. If they refuse to agree, either the survey is carried out, and the future demand fixed on some definite data, or arrangements are made with the revenue-farmer, to whom the estate is temporarily made over, the cultivating rights of the zamindars being, of course, maintained as long as they pay the latter the rent he demands.

It follows, therefore, that the British system enables two classes to live by the land, viz., the proprietor, who pays at the outside half of the rental or letting value of the land to the State, and the cultivator, who for his occupation of the land pays a cash rent or a share of the produce to the proprietor. Where the land is held by communities of peasant proprietors, as is generally the case in the Punjab and over a large part of the North-West Provinces, the cultivator merges in the proprietor, and thus the share of the total produce which the latter is able to retain after discharging his liabilities to the State is proportionably high. The difference between the net produce or the rental and the State demand represents a property of enormous value, which has only come into existence within the present century, and has increased in value, as the proportion claimed by the State

has been reduced, and as the growing facilities of communication and the opening out of new markets have enhanced the money value of agricultural produce, for the proverbial caution of assessing officers makes them slow to claim for Government at reassessment a full share in the enhancement due to rise of prices.

The most striking and important result of this policy has been to create in British districts an enormous demand for land among the non-agricultural classes and to inflate the credit of the landholders. Credit is based upon two things—the value of the property alienable, and the power to alienate. The growth of the former has been alluded to; the latter has been encouraged by our policy of free trade in land, and the general tendency of our legal system to recognise individual in reference to communal rights. Hence it has come to pass that no sooner had we granted to the landholding classes a valuable property than they began to alienate it by sale, mortgage, or gift. These alienations have largely been in favour of classes who heretofore had regarded, as they still regard in many native States, the possession of land as a burden not a privilege, and the class which has profited most by them are the village moneylenders, whose position enables them to take advantage of their *clientèle*, the village peasant proprietors, in seasons of scarcity or distress.

The economic distress—tending to grow into political discontent—which follows such widespread alienations, whereby the free peasant proprietor becomes the serf of the village moneylenders, has been forcing itself on the attention of the Government of India for the last generation, and among the legislative measures taken to cope with the evil may be instanced the Deccan Ryots' Relief Bill of 1875, the recent legislation prohibiting the alienation of the proprietor's home-farm in the Central Provinces, and the Bill recently passed into law, to amend the Indian Contract Act. The following extract from the speeches of the Legal Member of Council (the Honourable Mr. Chalmers) in charge of the Bill, will help to show the magnitude of the evil and the remedial measure proposed:—

"As honourable members are aware, the subject of agricultural indebtedness, and of moneylenders and their dealings with the poorer and more ignorant classes has long been engaging the attention of the Government. Opinions may differ—and may fairly differ—as to the nature of the remedies which we ought to adopt to meet an admitted evil, the magnitude of which differs considerably in different parts of India. We have been urged to put stern restrictions on the alienation of land, and to apply universally the provisions of the Deccan Agriculturists' Relief Act; but the conditions of tenure and of the land holding classes are so widely divergent in the different provinces of this great empire that legislation which would be suitable and beneficial in one province, would be unsuitable and prejudicial in another. We have been urged to extend to all classes the customs of *Damdupat*, according to which, interest on a loan can never exceed the principal; we have been urged to reenact the usury laws; and we have been urged to give the Courts a discretion in all cases over the amount of interest to be recovered in judicial proceedings. After careful consideration, we have rejected these suggestions. We propose now to enact the underlying principle and to propose that where the relations between the parties to a contract are such that one of the parties is in a position to dominate the other, and he uses his dominant position to impose unfair terms on the other, then the Court is to be empowered to open up the whole transaction, and either set it aside, or, if the parties cannot be restored to their original position, to see that right and justice is done. We have no wish to interfere with the freedom of contract where the parties to a contract are really fair, and contract with each other on a footing of equality. We recognise that, as Indian agricultural society is at present constituted, the moneylender is the capitalist, and an essential factor in it. We have no desire to eliminate or unduly harass the people who make loans to the agricultural and poorer classes. It is the abuses and excesses, and not the legitimate use, of the system which we wish to curb."

This digression is, I fear, a lengthy one, but it illustrates the far-reaching effects of our revenue policy, and shows that the gift of a valuable property, with power to alienate it, has proved in many instances a double-edged sword; that the ignorant and poorer classes have frequently failed to profit permanently by it; and that to prevent the last state of these men being worse than the first, legislation has been necessary to secure the benefit of the concession to those for whom it was intended.

In the ordinary Native State no such problems arise. As the State demand absorbs all or nearly all of the profits of cultivation, the possession of land offers no inducement to tempt the outside capitalist or the moneylender. Hence, in the majority of Native States there is no market for land except among the cultivating classes, who may be anxious for its possession in order to extend their cultivation. The occupier alone can live by the land, and there is usually no place for the middleman, *i.e.*, the non-cultivating pro-

prietor or mortgagee, as what he realises in rent from the cultivator is paid in revenue to the State. Again, alienations of land to outsiders are generally regarded as contrary to custom, and are only allowed in the last resort if the relations of the alienor or other members of the village community are unwilling to take it up. Thus the two elements of credit are either wanting or are very weak. The value of the property alienable is inconsiderable, and the power to alienate is much restricted.

One result of this, and by no means an unwholesome one to my mind, is that the zamindar's borrowing powers are infinitely smaller than in British territory, and his indebtedness is proportionately less. He can, usually, only borrow from a moneylender on the security of his standing or coming crop. The moneylender, of course, if he trusts his client, will, and often does, advance him far more than this, but in making his advances he naturally has an eye to the possibilities of future realisation. From the land he can expect little, as sales of land in execution for decrees of debt are not allowed in the two States of which I have personal experience, and the land, even if sold, would fetch little. Mortgage of the debtors' holding, though it gives the lender a hold over the latter, and is, therefore, sometimes resorted to, gives him no return for his money, while accumulation of the debt at compound interest is barred by the general rule that the State Courts shall not decree interest exceeding the principal. The moneylender is, therefore, less frequent and less powerful in a Native State village than in British territory. In an ordinary village of the Central Punjab, assessed say at one-third of the net assets, the amount paid annually by the zamindars to the moneylenders as interest on debts, equals, if it does not exceed, the assessment paid to the State, the debt on which interest is charged being generally owing to compound interest, &c., out of all proportion to the original advances; so that the moneylender intercepts most of the surplus profits remitted in favour of the landholders by the British Government, which in a Native State would go into the State coffers.

Thus the high pitch of the assessment in Native States—oppressive though it may be in some instances—acts as a safeguard against indebtedness and expropriation. The fact, however, remains that the poorer zamindars, paying a high and fixed cash assessment, must borrow at times to tide over seasons of drought or scarcity. They do so borrow, but not to the same reckless extent as their brethren in British territory, because they have not the same facilities, and they borrow less from the moneylenders than from the State—for agricultural improvements; and for their private necessities from the more prosperous members of their own class. To the latter, who are agriculturists themselves, they can give security by a temporary mortgage of part of their land, which would not attract the professional moneylender. Hence, while in British territory we find that moneylending to agriculturists is almost entirely in the hands of the non-agricultural shop-keeping class, in a Native State the agriculturists largely finance one another. The community is not as in British territory—where disintegrating influences have long been at work—joint only in name, but in fact as well. It is so from force of circumstances, having to hold together closely to keep its ground. The breakdown or desertion of any one shareholder reacts on the whole body, which has to assume liability for the weaker member. Hence the community will usually endeavour to keep a weak shareholder on his legs, and the most effectual way to do this is to keep him out of the moneylender's hands, by helping him themselves. In many British communities, the growth of individualism—so potent a force for development in some respects—has dealt a fatal blow to this co-operative spirit, and so far from a man giving a helping hand to his neighbour, he will give him a push downwards, hoping to profit by his fall.

In a Native State, therefore, the average zamindar, while he pays generally twice as much to the State as his neighbour in British territory would be paying for the same kind of land, is by that very fact prevented from rushing headlong into debt, and safeguarded in the possession of his paternal acres, while his neighbour, owing to the fatal facilities for credit, runs the risk of becoming hopelessly indebted to the professional moneylender, and is being more or less rapidly despoiled of his property by those who are in a position to take advantage of his ignorance and want of foresight.

A few examples will illustrate this argument more forcibly than any abstract reasoning. The two British *tahsils* of Nuh and Ferozpur, in the Gurgaon district, adjoin the Alwar *tahsils* of Kishangurh and Ramgurh on one side, the Bhartpur *tahsils* of Gopalgurh, Kama, and Pahari on another. The whole tract is inhabited by a homogeneous population of

Mohammedan peasant-proprietors—*Meos*—of the same race and habits. The agricultural conditions are practically the same, but the rate of assessment in Alwar is double, and in Bhartpur more than double of what it is in Gurgaon. All this tract was severely hit by the disastrous famine of 1877-78. To meet the scarcity, the British zamindars at once began mortgaging their lands to the moneylenders, and between 1st July, 1877, and 1st April, 1883, 13 per cent. of the cultivated area had been mortgaged in Ferozpur, and 8 per cent. in Nuh—mainly to outsiders. To such mortgages one might safely apply the maxim, "Once a mortgage always a mortgage," for it is the general experience of revenue officers that such mortgages by peasant-proprietors to moneylenders are rarely redeemed, except with the view of re-mortgaging for a larger sum to another mortgagee. In the Alwar and Bhartpur *tahsils*, on the other hand, where the distress was even more acute, and where the remedial measures taken by the State to alleviate it were infinitely less, not more than two per cent. of the cultivated area changed hands by mortgage within the same period. Nine-tenths of the mortgages were to brother zamindars, and many of these have since been redeemed. In 1883, 26 per cent. of the cultivated area in Ferozpur, and 20 per cent. in Nuh, was mortgaged, about two-thirds in each case being in the hands of moneylenders, while in 1898, the mortgaged areas in the adjoining Native States were only:—Kishangurh, 4·5 per cent., of which one-fifth was to moneylenders; Ramgurh, 9 per cent., one-fourth; Gopalgurh, 7 per cent., one-tenth; Pahari, 7 per cent., one-fourth; Kama, 5 per cent., one-fourth.

Of course, the fact that the zamindar is able to draw on his credit to tide over a bad year has many advantages, and probably at the time the distress of the Gurgaon zamindar was considerably alleviated by this resource. The matter has, however, another aspect. The British zamindar, with his extensive credit, bases his expenditure on the results of an ordinary year, and rather than reduce it in a bad one, has recourse to the money-lender, *i.e.*, lives not on his income but on his credit. In the recent Famine of 1896-97, in certain districts of the Punjab, though every facility was given to the people to earn a "living wage" by opening relief works at convenient centres, it was found that few of the zamindar class came on the works till they had exhausted their credit by borrowing all they could on their land at usurious interest, and rather than dig and work they sold land for what would be half its value in a normal year. Their brethren in Native States, who had not the same resource, were, on the other hand, found flocking to relief works in British districts, and the close of the famine left them in *statu quo*, whereas many of the British zamindars had become more hopelessly involved in debt, or even parted with their land altogether.

If sales of agricultural land were taken into account, the results would be even more unfavourable for British districts. In the Native States under consideration, sales of land to outsiders are almost unknown, and sales to co-sharers are mainly limited to cases where a zamindar, having got into difficulties or possessing a larger area than he can work, makes over part of it to a co-sharer often for no consideration, beyond assuming responsibility for future revenue and past arrears. To the British zamindar, on the other hand, the enormous increase in the value of land offers a continual temptation to sell. The sale statistics for the Punjab, in the year 1894-95, show that on the average land sold for 54 times the annual land revenue taken by the State, and in 1895-96, I think, the purchase money represented nearly 70 times the land revenue of the land sold. In Alwar and Bhartpur it is only in very exceptional cases that land fetches five times the annual land revenue; in fact, when land is put up for sale for arrears of land revenue, there is often no purchaser to come forward in Bhartpur. In both States I have had to dispose of a considerable amount of agricultural land—the property of the State, or abandoned owing to the desertion or breakdown of the owners—and have usually found it advisable to make it over to zamindars, merely subject to payment of the land revenue, or with the addition of a small *nazrana* or fine on entry. In Bhartpur, though the standard of the State demand has now been reduced to two-thirds or three-fourths of the rental, I often met with great difficulty in getting the landholders to take up abandoned estates or shares in them, merely on condition of paying the revenue which is now being assessed. They have so long been accustomed to having had to pay the full profits of the land to the State—wrung from them often with great severity—that they are unwilling to accept responsibility for the future.

In these remarks I do not by any means wish to contend that the native system is the

better one, but merely to illustrate how deeply the development of our revenue system has affected the economic situation in British territory. The benefits and evils of that situation are entirely our own creation, and, as things are measured in the East, of quite recent growth. This I think not only justifies but compels us to take up promptly the task of redressing the evils which our system has indirectly brought about.

In one respect the position of an assessing officer is much easier in a Native State. Though he may have frequent complaints of over-assessment by the State he is not continually confronted, as in a British district, with the complaint that the people are being expropriated by the moneylenders, that the Government is carried on for the interests of the latter, and that they are able to work the whole legal and executive machinery for their own purposes. This too renders the work of assessment more difficult, for one would wish to deal lightly with an involved estate, and yet if one does it is the moneylender who reaps most of the benefit. This conflict of feeling often ends in the assessment being tempered to suit the position of the weakest, and thus involves a sacrifice of the just claims of the State. It is to meet this state of things that proposals have recently been formulated in the Punjab for differential assessments, by which land acquired by non-agriculturists would be assessed up to the full half assets standard, and land held by the agriculturist classes be treated more leniently.

In the two States I have mentioned a re-assessment of the revenue is now being carried out which aims at leaving to the landholders from one-third to one-fourth of the net assets, or rental, as their share of the profits. This at once enhances the value of their holdings, and makes them an object of desire to the money-lender and the capitalist. As it is the desire of the States that the agricultural classes for whom this liberality is intended should continue to enjoy it, they have anticipated possible evils by prohibiting the alienation of agricultural land to others than members of the same village community, or for special reasons to agriculturists of other villages. The rare cases in which it is necessary for the development of large areas of waste land to attract outside capitalists are met with by a special proviso allowing such alienation with the consent of the State.

The above remarks make it clear that though the British and native systems are based on the same theory they differ enormously in the practical working and in the results. The so-called ownership of the land-holding classes is a very limited and subordinate ownership in Native States, and the superior rights of the States, which in British India lie dormant and are only evoked when the landholder fails to discharge his comparatively lenient liabilities, are much more in evidence under a native ruler. This shows itself in innumerable ways, of which I will cite only a few of the most prominent.

In the case of waste land, the native theory recognises in the landholders only a right of user at the very most, and reserves to the State the right to allot it to outsiders for cultivation or grazing, or to enclose it for State purposes. The tendency of the British system, on the other hand, has been to divest itself, as far as possible, of all direct connection with the land, and to encourage the landholders to appropriate as much of the waste as they would undertake the ownership of, at a normal assessment. Thus it was only the hill-forests, for which no claimants were forthcoming, and the great expanses of virgin jungle, of which there was no actual occupier, and to which the adjoining communities preferred no claim, that were usually constituted State property.

Again, having once recognised the ownership of the landholder in the land, the British system makes that ownership complete and absolute, while the native system merely recognises the subordinate rights of the landholders as long as they do not clash with its own needs.

Thus, when the British Government takes up land for a road or railway, or other public purpose, it pays not only the full market value of the land, liberally assessed, but an addition of 20 per cent. in consideration of the forcible acquisition. The Native State, on the other hand, takes possession of the land without paying any compensation, and merely remits the assessment, in consideration of the fact that the landholder is no longer in occupation.

The British landholder may deal as he pleases with the trees growing on the land, and may kill any game that finds its way on to it; while in many native States the Raj claims either the most valuable trees, such as *shisham*, or all the trees growing on waste lands, and often in cultivated lands as well, and the landholder is prohibited from cutting them for agricultural purposes, even when injurious to his land. I have come across numerous cases in a well-governed State where every tree and

shrub, whether growing on cultivated or waste land, or even in the enclosures round houses, is claimed by the State, and where any attempt by the people to cut a few sticks for firewood, or for burning a corpse, from land in their own occupation, is severely punished.

In a Native State, too, the game laws are often worked with a severity worthy of William Rufus. We hear a good deal about the restrictions on firearms in British territory, and of the cruelty of refusing licences to enable the people to protect themselves and their fields from wild animals; but in the Native States I refer to only a few of the chief officials and of the leading nobles are allowed to possess firearms or to shoot game of any description. Recently, when inspecting his estate, I asked a Rajput notable, whose only amusement was opium eating, why he did not go in for sport. His explanation was, "My grandfather once shot a wild boar, and the Maharaja had his hand cut off. My father killed a deer, and was fined 500 rupees. Is it likely that I should run a similar risk?" A year ago, when returning from a tour in this same State, I met a policeman carrying a fine panther skin. In reply to my questions, he explained that the panther had a few nights before burst into the sheepfold of a neighbouring village. The owner of the sheep had rushed to their rescue, and, clasping the panther round the neck, had held him tightly till his friends, attracted by his shouts, came to his aid, and slew the panther with their cudgels. I remarked that the man must have been a very brave one, and deserved a reward. The policeman, with a smile, said, "This is his reward," and pointed to a figure in chains, who turned out to be no other than my hero. He had broken the State laws by killing a wild animal, and, all wounded as he was by the mauling, was being sent in for trial. Of course, under the circumstances, he would probably have been acquitted in the long run, but I was glad to be able to accelerate his release. The case illustrates the jealousy with which native rulers, if fond of sport themselves, as most of them are in Rajputana, protect game of all kinds. Our more liberal policy has cleared British districts of Northern India of all big game, and he who thirsts for happy hunting-grounds must now seek them under the ægis of native rule.

Another matter in which the Native State exerts its right of interference is as regards the internal administration of the village community. In British India the complaint is frequent that over-legislation, with its attendant red-tapeism, and officious interference, is making our rule unpopular. In some respects, at least, our system is less inquisitorial than under native rulers. As regards the liability of the community to the State, having fixed this at the time of settlement for a term of twenty or thirty years for the estate as a whole, and the individual holdings that make it up, we leave the people to themselves, allow them, with the assistance of the *patwari* or village accountant, to regulate the distribution of the annual State demand on the lines laid down at settlement, and to make their own arrangements with their tenants, limiting our interference to cases in which complaint is made of fraud or over-realisation. The Native State system takes a much wider view of its position. The assessments are much more frequent. In one of the States I am dealing with there have been no less than nine separate re-assessments within the last 42 years, involving not only an uncertainty fatal to steady development, but a continual harassment of the people by the revenue and assessing officials. The people are also encouraged to redistribute the revenue annually, according to fluctuations of cultivation, and though this gives more elasticity, it deadens individual energy, and opens the door to continual interference by the State officials, who often work the system for their own advantage. Again, even where the landholders are admitted to be proprietors or sub-proprietors, the State asserts a right to regulate their dealings with their tenants, and if they take from the latter a higher rent than the revenue they pay to the State, this is regarded as illegal, and the excess is confiscated by the State, not restored to the tenants. This system gives rise to vexatious complaints and drives the landholders to subterfuges, the most common of which is to record a nominal rent, agreeing with the State demand, and, in practice, to exact a larger one where this is possible. Hence it is infinitely more difficult to ascertain the real rents in a Native State, where the people fear that any profits that may be disclosed will be claimed in full by the State, than in British territory. Coming from a British district, where the landholders, conscious that they would be dealt with fairly, had met me frankly and candidly disclosed their rents and profits, it was rather a shock to find that in a more primitive, and, as I had hoped, a more unsophisticated society, I had to deal with a people whom the system had made adepts in the arts of subterfuge and concealment.

Relation of Proprietors to Non-proprietors.

I have left myself little time to discuss the second branch of the comparison—viz., the relation of the proprietary bodies to the non-proprietary cultivators. This will be more eadily understood after what has been already said as to the superior rights and lesser liabilities of the proprietors under British rule. The large margin of the profit left to the landholders leaves room for the creation of a number of subordinate rights in land, besides that of the actual proprietor. Thus, intermediate between the latter and the tenant-at-will, cultivating from year to year at a full competition rent, we find the various classes of protected or occupancy tenants, who are not liable to ejectment, except for non-payment of rent, and whose rent is usually fixed by the State, and cannot be enhanced beyond a certain limit, nor even up to that limit, without an order of Court. Such rights are generally acquired by persons who are not members of the proprietary body, but who have for generations resided in the village, and occupied the land continuously on payment of a prescriptive and non-competitive rent. The legal position of these tenants is very similar to that enjoyed by the Irish farmers under the present Land Acts ; and though the position was originally regarded as of little value, and at the early settlements of Punjab districts, 40 years ago, the cultivators were often unwilling to accept the liabilities for the land revenue, which the possession of such rights entails, it is now eagerly coveted, as having a value little inferior to that of actual ownership of the land, and is one of the most fruitful sources of litigation between landlord and tenant.

In a Native State the powers of the proprietor are so restricted, and his liabilities so considerable, that hardly any room is left for the growth of such subordinate tenant rights. The most common phase is that while a certain body is recognised as the proprietors, and these are directly responsible to the State, still they and the non-proprietary cultivators contribute at the same rates to the payment of the State demand for the land which they cultivate. The only advantage which the proprietors possess is that, as in British territory, they have the disposal of the cultivation, the management of the waste or common land, and receive through their representatives, the village headmen, an allowance of from 3 to 5 per cent. from the State on the revenue, while they are also empowered to levy a cess for village expenses, and to claim certain manorial dues, such as fees on marriage, &c., from non-owners.

Where the line of cleavage between owners and tenants is so indistinct, it will be readily understood that there is not much differentiation of classes among the latter. Thus the burning question of landlord and tenant in British India rarely arises in a Native State. The density of population is less, and the amount of waste land is generally so considerable, that the competition is more frequently among landlords for tenants than among tenants for the right to cultivate, and this, combined with the tradition that owners and tenants should all pay at the same rate, makes their position a fairly secure one. Claims by landlords to eject tenants, and claims by tenants to secure their position as against the landlord by obtaining rights of occupancy, are, therefore, comparatively rare. Even here, however, we can trace the influence of the British system with its tendency towards full competitive rents, and towards more sharply defining the positions of landlord and tenants or owner and cultivator. In those parts of Alwar and Bhartpur which adjoin British territory the owners are now following the example of their neighbours and beginning to claim enhancement of the customary rent, so as to secure for themselves part of the margin of profit—from one-third to one-fourth of the rental—left under the new assessment by the State, while the tenants, who were hitherto content with their undefined and customary status, have responded by coming forward with claims for occupancy rights. In the four northern *tahsils* of Bhartpur adjoining British territory, we have had to deal with about 10,000 such claims within the last two years. The movement has not yet spread to any extent among the more remote parts of the State, though the standard of assessment is the same, and in these the owners are far more willing to concede than the tenants are to accept the occupancy or protected status. They have as yet only dimly appreciated the advantages of such a position, while they still, with the memory of past over-assessment fresh in their minds, shrink from undertaking the responsibility for the land revenue which is incident to it.

Hitherto, I have dealt with some of the points of difference in the native and British systems, and the results they produce. The query will occur to many minds—which of the two conduces most to the happiness of the

people? This query presents perhaps too many varying aspects for any satisfactory attempt at generalisation, but all the same speculations of this kind have an attraction of their own, and, therefore, with every desire to avoid dogmatising, I think a few considerations may be ventured on the subject. If by happiness, we mean contentment with one's lot, I think, in many Native States, the scale would be found to weigh down in favour of the native system, while if we interpret happiness in the strictly utilitarian sense of material progress and prosperity, then the British system is undoubtedly and immeasurably superior. Which of the two ideals of happiness the native mind pursues, is a question not easy to solve, and the longer one resides in the East, and the closer one studies the people, the less ready is one to offer a solution.

Under the British system the State demand is lighter, there is more freedom, more scope for individual effort, a higher standard of comfort, and more security that he who sows shall reap; in fact, the system encourages enterprise and energy. On the other hand, though the assessments are lenient, they are more rigidly collected, the freedom allowed to individual effort often leads to the disintegration of the community, and enables a strong and unscrupulous member to aggrandise himself at the expense of the rest. The wider margin of profit left to the landholder attracts the moneylender and the speculator, who often intercept for themselves what the State foregoes in favour of the proprietary classes.

The high value of land, and the distinct and often conflicting interests therein—thereby created—conjoined with an elaborate and technical legal system, foster litigation, as well as indebtedness, and tend, unless checked by special legislation, to favour the expropriation of the weaker and more improvident landholders. Thus while material progress and rapid development are encouraged by the British system, they are accompanied by disintegration, inequality, and economic discontent. The native system tends to keep all members of the landholding classes on a common level. This not infrequently means stagnation, but this stagnation tends towards equality, and consequently to contentment.

The landholders of the Central and Western Punjab who have—partly by their own improvidence and partly through the effects of our legal system—been dispossessed of their hereditary lands, and now cultivate them as the tenants of the moneylender are, I believe, no worse off, materially, than the majority of the landholders in a Native State. What chiefly galls them is the sense of inequality. They have been shorn of privileges which their brethren still retain, and they have to endure the spectacle of an outsider, often alien in race and religion, grown fat at their expense. With these "wounded soldiers" of the campaign of progress and individuality it is useless to argue that they are the authors of their own misfortunes, that they have themselves thrown away the benefits which our system has conferred upon them, that their position is no worse than it would be under native rule. The difficulty of making the Oriental mind accept logical conclusions has been for generations the despair of Indian administrators. All that it can grasp in the above phenomena is that the expropriation of the landholding classes has practically begun and proceeded apace under the British Raj; therefore, the British Raj is responsible for and must bear all the odium attendant upon the results of such expropriation. It does not stop to consider how enormously other portions of the community or other members of the same community have benefited by the same system. The views of the "submerged tenth" are apt to influence and colour those of the entire agricultural community. This, though its position has, on the whole, been immensely improved under British rule, realises that its progress has been much slower than that of the great non-agricultural middle-class, which has been in great measure the creation of British rule, and which has largely grown at the expense of the agriculturists. It does not at the same time realise clearly or fully that its position is immeasurably superior to what it would have been under native rule, and what it still is under similar communities in Native States. The position is a difficult one to explain, but the genius of a poet, possessed of an innate insight into the workings of the Oriental mind, has laid it bare in four lines:—

> "By all ye will or whisper,
> By all ye leave or do,
> The silent sullen peoples
> Shall weigh your God and you."

DISCUSSION.

The CHAIRMAN first read the following letter which had been received by the Secretary of the Section from Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.:—

"I had fully intended to stay in town to-morrow, and hear my friend O'Dwyer's paper read, but I

regret to say that circumstances have occurred which make it necessary for me to leave town sooner than I expected. I am obliged to you for sending me the proof sheets. The paper seems to me a good, sound discussion of the comparison taken of the subject. It does not seem to me to be open to much discussion. The only remarks which suggested themselves to myself, after reading over the paper, were:

"(1.) That I believe the Panjab revenue assessments are nearer their standard of half net assets than Mr. O'Dwyer supposes. The methods by which the net assets or net rent are worked out by Panjab Settlement officers, give, I believe, an exaggerated estimate of the true net rent.

"(2.) I do not believe it would be possible for our collectors and their establishments to collect a revenue near as heavy as that collected in Native States from peasant proprietors. It would end by a break down, and the loss of their property by the peasants, as it always did in old days when the rates of our assessments were very heavy. A ruler of a Native State and his officials can do in this direction much that we cannot do.

"Mr. O'Dwyer does not in any way propose that we should follow the Native States, and raise the rate of our assessments, but there was in India a party which preached that doctrine, and which might take hold of what he says to use as an argument."

He then proceeded to say that having had several years' experience of Native States, first at Hyderabad and afterwards in Rajputana, he thought Mr. O'Dwyer's summing-up of the merits of the two systems was a very fair one. If a person was content with his lot, and did not want to get on, or to raise his standard of comfort, but only to live as his forefathers had done, he might be rather happier in a Native State, but if he wanted to acquire rights and property he ought to be happier in a British district. There the education was better, which, perhaps, was not an unmixed good, but still it had been pushed on, and we could not go back upon it now, any more than we could in England, where he constantly heard that education was the reason why good servants were scarce. That was a point which did not apply to the Native States. It should also be remembered that Mr. O'Dwyer did not profess to do more than to speak as to two Native States, with which he was well acquainted, both of which adjoined the North-West Provinces, and had been for some time during minorities under the administration of British officers. He was not sure that other Native States in Rajputana would accept the statement that the ryots had no rights in the land. On this point he should like to quote what Colonel Tod said in a most valuable book, which was not so well known as it ought to be. The rajas, according to Colonel Tod, did not claim to possess the soil, but to have a rent, which they fixed themselves, because they gave protection. The soil, however, was supposed to belong to those who cultivated it. Colonel Tod said:—

"The ryot (cultivator) is the proprietor of the soil in Mewar. He compares his right thereon to the *a'khye d'hooba* (a grass which cannot be eradicated) which no vicissitudes can destroy. He calls the land his *bapota*, the most emphatic, the most ancient, the most cherished, and the most significant phrase his language commands for patrimonial inheritance. He has nature and Menu in support of his claim, and can quote the text, alike compulsory on prince and peasant, 'Cultivated land is the property of him who cut away the wood, or who cleared and tilled it,' an ordinance binding on the whole Hindu race, and which no international wars or conquests could overturn. In accordance with this principle is the ancient adage not of Mewar only but all Rajputana, *Bhog ra dhanni Raj ho: bhom ra dhanni ma cho*—'the Government is owner of the rent, but I am the master of the land.'" On another page Colonel Tod writes: "There are two methods of levying the revenues of the Crown on every description of corn, *kunkoot* and *bhattaic*; for on sugar-cane, poppy, oil, hemp, tobacco, cotton, indigo, and garden stuffs a money payment is fixed, varying from two to six rupees per beegah. The *kunkoot* is an agricultural assessment of the standing crop, by the united judgment of the officers of Government, the patel, the patwari or registrar, and the owner of the field. The accuracy with which an accustomed eye will determine the quantity of grain on a given surface is surprising, but should the owner deem the estimate overrated he can insist on *bhattaic* or division of the corn after it is threshed, the most ancient and only infallible mode by which the dues either of the Government or the husbandman can be ascertained. In the *bhattaic* system the share of the Government varies from one-third to two-fifths of the spring harvest, as wheat and barley; and sometimes even half, which is the invariable proportion of the autumnal crops. In either case, *kunkoot* or *bhattaic*, when the shares are appropriated, those of the Crown may be commuted to a money payment at the average rate of the market."* He quoted those remarks because he thought that when Mr. O'Dwyer's paper was printed, if it reached some of the Native States they might say the statement that there was no margin of profit for the cultivator did not quite apply to them. A person in England who knew nothing about India might be inclined to say, "Surely you can tell which of the two systems the natives value the most, because if they did not like the British system they would emigrate into the Native States, and if they did not like the native systems they would emigrate into the British districts." That was a fallacy, and emigration statistics were of little value. Even in famines it was most extraordinary how the inhabitants of whole tracts of country would come into British districts, and when the panic was over they would go back to the place they came from, and scratch at the soil of their forefathers as they had done years ago; they

* Tod, "Annals of Mewar," pp. 494, 502.

never seemed to want to leave their native land. Migration statistics, therefore, did not affect the argument. The majority of English officers must concur in what Mr. O'Dwyer said, that it was necessary for the Government to take some steps to redress the great evil, which had almost become a political danger, whereby, in the British districts, the cultivating class were being ousted from their paternal acres by the moneylenders. He doubted if the power given to the Courts to go behind the contract, which had been referred to in Mr. Chalmer's Bill, would suffice, and made some remarks describing the system whereby ignorant cultivators who depended on the Bunneahs for everything signed blindly in the books of the latter and executed bonds in which it was very difficult to determine what was principal and what was interest. The whole subject was a very difficult one which the Government had been considering for a long time, and he would be glad to see how the new change in the Contract Act worked, but he doubted very much whether it would be sufficient. No doubt many people had been struck by the brilliant pictures which Mr. G. W. Steevens had been giving in the *Daily Mail*, of his interesting experiences in India, and one short passage he had just read was worth quoting :—"The difference under our rule is not so much that justice is done, as that the law is enforced. The rich man benefits under this, for a raja's government would seldom let a rich man get out of a law suit with a full pocket; but the poor man suffers in the same proportion. In the old days the poor debtor was protected by the rapacity of judges and government. The usurer dared not go before the raja for leave to attach the peasant's stock and crops and land. 'Aha,' his Majesty would say, 'You must have been making money, my friend; we must look into this.' But in a British court the sacred contract must be upheld, and the ryot is ruined." Unless something was done more than had been done a great deal of discontent would remain in the British districts. As for Native States they differed greatly; in some people might be happier than the majority in British districts, though there was no comparison between the officers who administered justice in the Native States and in the British districts. Still, natives liked their own ways, they understood the native judge, and he understood them. He did not always limit himself to the evidence before him, as the British judge was obliged to do, and in that way a sort of rough-and-ready justice was sometimes done which the English Courts could not arrive at. Still the fact that the best governed States borrowed largely from British administration in all departments spoke volumes in favour of the principles we had long been trying to inculcate. The Chairman concluded by inviting remarks from other gentlemen present on the subject of Mr. O'Dwyer's able and interesting paper.

Mr. T. DURANT BEIGHTON said that Mr. O'Dwyer from the position he held—for his services at one time had apparently been lent to a Native State, and at another time he served as a settlement officer in British India—had been able to make a most interesting comparison between the two systems. They had learnt that both in the British dominions and in the Native State, the Sovereign Power considered itself entitled to a certain proportion of the proceeds of every acre of land; but while the Native State had adopted the principle of rack-renting, and confessedly discouraged the formation of a zamindar class, or of any intermediate class between themselves and the actual rentpayers, the British Government had contented itself with a very much smaller share, and this had given rise to the creation of a large number of proprietary bodies intermediary between the Government and the actual cultivators of the soil. It naturally followed from the creation of these intermediary tenures that there were a large number of saleable interests involved, and the result was a fatal facility for parting with these interests to moneylenders; and this had further resulted in the expropriation of a large number of the smaller proprietors and tenants. In the Native States, at least those mentioned by Mr. O'Dwyer, matters were entirely different, and he thought Mr. O'Dwyer must have been conscious—or possibly unconscious—of a certain amount of humour when he drew so striking a contrast as to what happened in the respective districts. The Native States had certainly taken every precaution for preventing the squandering of the property of their people by taking very good care that they should have none to squander. They had done away altogether with the possibility of any money being borrowed by depriving their subjects of all security and of all credit. It was impossible for them to sell their birthright for a mess of pottage, because they had no birthright whatever to sell. That was the attitude of the two Native States of which Mr. O'Dwyer spoke. The Native State, therefore, was in the position of a beneficent mother, whereas the English Government, from this point of view, would appear to be acting somewhat in the manner of the bad fairy in the nursery tale, by giving gifts to her children which ultimately led to their ruin. It was only fair to say, however, that Mr. O'Dwyer had also dwelt thoroughly on the reverse side of this picture. They had heard of the advantages of British rule, the encouragement and progress of agriculture and commerce, and of this they were all conscious; but there was one advantage which had not been mentioned, namely, that the system of which they were speaking had resulted in the formation, at any rate in Bengal, of a large body of loyal, well-educated landowners, who played a very important part as intermediaries between the Government and the people in the furtherance of any measures of reform, social or political, and that, from the very nature of the case, could not be expected in the Native States. In the very interesting speech of Mr. Chalmers, in introducing his Bill to amend the Contract Act, which had been quoted, there was one pregnant sentence to the effect that, "where one of the parties is in a position

to dominate the other, and he uses his dominant position to impose unfair terms on the other, then the Court is to be empowered to open up the whole transaction," or modify it. He wished to state as emphatically as he could that the results of that enactment would depend entirely upon the interpretation the Courts chose to put upon it. He had had considerable experience as a judicial officer in India, and had found that the Courts had been apt to place too hard and fast an interpretation on the letter of these contracts. Over and over again cases would be found, on searching the records and reports of the High Courts, where the letter of a contract had been too stringently enforced—very often causing great injury and injustice to the debtor. Over and over again, the subordinate Courts had endeavoured to do justice between the parties, but they had been overruled by the High Courts, especially the High Court of Calcutta. There had been a great and increasing change in public opinion both here and in India with regard to the tyrannies connected with usury. A Select Committee of the House of Commons had been sitting in England, and he understood a Bill was before Parliament dealing with the matter. He wished the Legislature in India had seen their way to pass a hard and fast rule that the interest decreed by the Court should never be greater than the amount of principal borrowed. Without some such rule he feared that the letter of the law would continue to be too strictly enforced.

Sir JOHN JARDINE, K.C.I.E., said there were many facts stated in this lucid paper which could only have come from personal experience in the districts Mr. O'Dwyer had been settling, and his statement of the difficult question about the happiness of the people in different districts was admirably expressed. When Lord Lawrence was Viceroy he put the same question to a great many officers there, and the replies he got showed a good deal of knowledge and a great deal of variety of opinion. The Chairman had stated succinctly what most people would think about it, that the ryot in British territory, with his larger possessions, more valuable rights, and an opportunity of a better career, ought to be happier than his counterpart in a good many Native States; but whether he was so in fact was the important question which Lord Lawrence wished his officers to solve, and that was more difficult to answer. It was somewhat like the question discussed by poets, when they contrasted the adventurous and busy life of cities with the ease and quiet of the country, generally preferring a rural life; but when you went into the country you saw that the people living in those beautiful villages had grievances too. And any one who had been through the Native States, and had much to do with the people, would find that they too had grievances. Of course, it depended a great deal on the temperament of the particular people and their rulers. Some of these Native States had been in British hands for some time, and had accepted a modified form of the British land revenue system. Sometimes you find a tyrannical prince, as was not uncommon in the old days, but in the south of India, where the Mohammedan doctrine that the State had absolute property in the land never much prevailed, the Hindu law was remembered by the Hindu princes and rajas, and they usually put a considerable restraint on the exaction of land revenue, although very often, in the course of time, new taxes got added on to it, and this made it ultimately an oppressive burden, which soon after the British invasion began to be redressed. He spoke of the Bombay Settlement, which was afterwards extended, under Lord Lawrence, to Berar and Mysore. That began in the time of Mountstuart Elphinstone, who wished to preserve the native system as much as possible, but he wrote that the British sentiment and the native sentiment on a great many points were absolutely opposed, and some of the things he wished to preserve would be regarded with disgust by British officers, whilst many things they thought first-rate would be looked upon by the natives with abhorrence. He foresaw that when the officers were appointed by seniority and not by selection it would be difficult to manage a system by British officers on native lines, and, therefore, a compromise had to be made. He began by reducing the rate—i.e., the half or third of the net profit on land; but even that was found to be too high, and it was decided to reduce it, fixing it according to the quality of the land, the neighbourhood of markets and so forth, and out of that arose the Bombay Revenue Survey, which brought in another benefit, of which the Native States had availed themselves—the mapping of village lands, putting down boundary marks, getting evidence about rights and so on, which pre-appointed evidence was useful for all time to come and saved a good deal of litigation. One result was that waste land came far more into cultivation and the Government gained in that way. As time went on the selling price advanced, though never in rural districts, up to 54 times the assessment. He thought it was generally between 12 and 20 times the annual rent. On the whole the cultivators were satisfied. Sir Bartle Frere, in 1865, brought in a measure which levelled up most of the tenures of the Presidency. There were a few valuable tenures, which were supposed to be so fixed that for a long time it was thought that after any length of time a son might come back and reclaim the land. What the Government did was to give the unprivileged ryot a hereditary and transferable title so that the son was not dependent upon the Government for his tenure from year to year, but had a right to keep it on if he chose to pay the assessment, which was not to be altered until the end of a long term, usually 30 years. Some of these leases had fallen in, and the Government had raised the rents generally without difficulty. He had been much struck with what he saw in the report of what may be called the settlement officers in Britain, that is the Commissioners who visited England, Wales, and Scotland, collecting evidence with regard to agri-

cultural depression. One object of Sir Bartle Frere was to prevent the farmers being evicted from the soil, and the Blue-books of the Agricultural Commission seemed to show the same evil here, and in many counties the farmers had shown a desire for fixity of tenure. It appeared that in Nithsdale out of 245 farms there were 172 new tenancies, the new people being often bankers, merchants, and business men, and this coincided with Mr. O'Dwyer's remarks about people not connected with the agricultural classes getting a footing in the Indian villages. He remembered, when First Assistant-Collector of Poona, noticing how curious the street of Ambegaon appeared, more like a village in Gujerat, and the ryots told him that the houses were the shops of the Gujerat moneylenders, who had become owners of nearly all the houses, while the original inhabitants were now slaving on the fields that once belonged to their fathers. That grievance was very much felt. Some years ago they were rather startled when a district judge in Bombay found in the report on which the survey was founded that it was the intention of the founders of the settlement to get rid of the poorer cultivators. Influenced as the statesmen of that time were by such authorities as Bentham and the political economists, they suggested that there was no disadvantage, but only an advantage in getting rid of farmers without capital, and getting capitalists in instead. It was really a change of opinion which had come over the official world in India between that time and this, as the evils grew greater, and that had led to a much more general feeling in favour of the extension of the equitable doctrine, so as to protect the farmers, as ignorant men, against the moneylenders, who were better educated. This influence was now strongly felt in legislation. First, it was applied to the great landowners, afterwards to the common ryots; and although there was much discussion about the theory and the result, he was inclined to think that the policy had justified itself. Not long before he left India he read a report on the Deccan Relief Act, 1875, by a district officer, who said that he noticed that the houses of the people were better, and they seemed to be living more happily. As regarded the judicial arrangements, he believed the system had worked well, and he wished those who attacked the High Courts would remember that it was not the Executive but the judges of the High Court of Bombay who had introduced English doctrines of equity with regard to mortgages so as to give the owner of land the right to redeem, and to protect him, as far as English equity could, against oppression on the part of his creditor.

Mr. ALEXANDER ROGERS said the main point to be considered was whether the ryots generally, including the zamindars, should be taxed to the utmost—that is, rack-rented—or not, and which was the most favourable system, taking into consideration the position of the people on one side, and of the Government on the other. It was acknowledged, in the summing up of the paper, that the British system, which allowed a certain margin of profit to remain with the cultivators, had tended to the increase of prosperity, and the main point to be looked at was whether it did so or not. He had had a good deal of experience in revenue matters, but not in districts such as had been described in the paper. He had had to deal with *rayatvári* districts, and he maintained, from actual experience, that the Bombay Revenue Survey, as contrasted with the Madras system, had acted for the best. In Bombay a margin of profit was deliberately left to the cultivator in order to give the land a saleable value. The result was you could not find a scrap of land waste which was not taken up. In other districts, as in Madras, where that margin was not given, although the Madras people said it was, the result was that instead of there being no land to be got, there were over 6,000,000 acres of arable land waste. The revenue was collected in a great measure by evictions of the tenants, and when their land was put up for sale by auction to realise the Government revenue, 30 to 40 per cent. had actually to be bought in by the Government themselves. Mr. O'Dwyer acknowledged that the Bombay system encouraged enterprise and energy; on the other hand, though the assessments were more lenient, they were more rigidly collected. That was a matter of administration, and was entirely in the hands of the Government and Collectors; nominally the assessments were rigidly collected, but in reality they were not. The Collector of a district knew what the result of his operations would be, and he must be a born fool if he taxed the people so as to drive the land out of cultivation. The assessment was revised every thirty years, which afforded a test as to how it succeeded. At the time of revision careful statistics were collected to ascertain whether the condition of the people had improved or deteriorated. His experience was that there had been an increase of comfort in various ways. If tiled houses had been substituted for thatched houses, if the number of cattle had been increased, if the returns from the Courts showed that the value of land had increased, all these were signs whether the Bombay assessment system had answered. He could appeal to printed reports to show that it had afforded inestimable benefit, on the whole, to the cultivator in Bombay.

Mr. W. COLDSTREAM said Mr. O'Dwyer had presented a most accurate picture of the state of things which he had observed, as might have been expected, as he was an officer of exceptional ability, with a great talent for observation. It was quite true that the native system, which prevented the growth of market value in land, might (in a sense) be regarded as a real good in the present condition of things over a large part of the empire. There was no doubt the effect of the British system in the Punjab had resulted in some degree of injury owing to the ignorance

of the cultivators. Land had suddenly acquired a substantial marketable value, mortgages and sales were allowed, and supported by the Courts, and the zamindars forthwith began to taste the pleasures of the command of cash. They borrowed for marriages, for jewellery for their women, and mortgaged their land to its full value; the result was that many thousands of acres had passed for ever out of the hands of the original proprietors. The remedy, of course, was in the gradual education of the people and the progress of the country. When the landowner came to contract with the moneylender on an equal footing the evil would be remedied. They were now in a transition state, but he had no doubt that, in the course of a generation or two, things would settle down, and the maxims of prudence would prevail. The paper was a most practical and useful picture of the present condition of things and therefore of historical value. He thoroughly sympathised with the Chairman's allusion to Colonel Tod's book. It was a trustworthy description of the condition of Rajputana at the beginning of British rule; a valuable text-book and treasury of facts. Now-a-days the work of officials did not leave them time or energy to enter into these questions the way Colonel Tod did 80 years ago. As to the game laws in Native States for the protection of wild pigs, he had known of crops much damaged because the raja would not allow the zamindars to shoot the pigs, and much dissatisfaction resulting. In one native State the nilgae became very numerous, so that the zamindars' fields were periodically browsed down, and the nilgae, being considered a sort of cow, could not be slaughtered in accordance with the Hindu religion. However, after a time, a reference was made to Benares, and it was finally settled that it was not a cow, but a deer, and since then in that State the nilgae had almost ceased to exist.

Sir CHARLES CECIL STEVENS, K.C.S.I., said they had it on classical authority that a traveller with empty pockets would sing in the presence of the robber; but yet it had always seemed to him a little difficult to understand that a ryot who had neither property in his land, nor credit, could be happier for it. It would, at any rate, be scarcely safe to apply to the whole of India conclusions which were doubtless sound enough with regard to the portion of the country covered by Mr. O'Dwyer's remarks. He had had a good deal to do with these matters in Bengal, having been the member of the Board of Revenue who had had to deal with the enquiries preliminary to the law recently passed, and it was his duty to study the question of the prevention of the alienation of lands. After examining the facts, he came to the conclusion, in agreement with the great weight of opinion among the revenue officers, that the evils arising from the transfer of land in Bengal could be nothing compared to what they heard described by their brethren in the Punjab and other places. It seemed to him, therefore, that it was not necessary to pass a sweeping law for that Province, and the recent legislation of the Indian Council contained the remedy which had struck him as being appropriate to the conditions of Bengal. Whether it would be sufficient for other Provinces, or whether something more drastic would be required he could not attempt to say; for he had been sufficiently long in India to appreciate the value of local experience and knowledge. So far as Bengal was concerned he could not accept the statements contained in the paper as entirely appropriate to either the British territories or the Native States. Their experience of the latter in Bengal was not very large: but, as Commissioner of the Chutia Nagpur division, he certainly thought the condition of the cultivators was happier than it seemed to be in those more important States of which mention had been made in the paper. There the zamindars were understood and were allowed to receive profits, and cultivators breaking up new land and labouring to make it productive, received much consideration; and the same thing was to be found in those parts which had comparatively recently come under British control. Nowadays, the moneylender in Bengal was acknowledged to have his uses. Very often he was not such a professional moneylender as those infesting other Provinces, but an inhabitant of the village, who operated in a very small way. It was to his interest to keep his ryots going, and he (the speaker) well remembered that during the scarcity or famine of 1882 to 1883, when he was the Collector of a district, the moneylenders were of the greatest possible service in helping to carry their ryots through their difficulties. An old friend of his, an indigo planter, who had lived among the people for many years, and had a very intimate knowledge of them, had told him that he found these moneylenders had a sentiment of *dharma* in the matter; they felt the ryots were dependent upon them, and it was their duty to assist them.

The CHAIRMAN then proposed a vote of thanks to Mr. O'Dwyer, which was carried unanimously.

Miscellaneous.

*COMMERCIAL EDUCATION IN ENGLAND.**

BY SIR HENRY TRUEMAN WOOD, M.A.

(Continued from page 574.)

For scientific and technical education, we have yet other separate organisations. The higher scientific education, it is true, is to a very large extent under the dominion of the Universities, especially of the younger

* A paper read at the International Congress on Technical Education at Venice, May, 1899,

Institutions, such as the University of London, the Victoria University (Manchester), and the important provincial Schools and Colleges, mostly of recent origin and affiliated to the newer Universities. Elementary scientific instruction, however, like elementary education, is under Government control. As far back as 1836, Schools of Design were founded under the control of the Board of Trade. In 1852, a Department of Practical Art was established—soon after changed into the Department of Science and Art, which still continues as a separate Department of the Government, but is about to be combined with the Education Office into a general Department of Education. As at present constituted, the Department has under it the Royal School of Mines, the Normal Training College for Science Teachers, known as the Royal College of Science, and also the South Kensington Art Schools, known as the Royal College of Art. These are all in London. It also administers certain branches in other parts of the kingdom. The most important part of the work is, I think, its examinations. These were established for Science subjects in 1859. As early as 1853 experimental science schools were established in selected centres in the country, and a system of examination was introduced in 1859. Payments were made on each student passing an examination, and by this means a revenue was provided for these schools, and for numerous other similar schools which were established all over the country. Grants in aid of the schools were also made under certain conditions. This system, which is now being gradually superseded by payments on attendances, is open to criticism, and I believe this country has been allowed to retain a monopoly of the method of payment on results. Perhaps its apparently practical character recommends it to the English mind. It had at the outset many drawbacks. It encouraged cramming, and aided not a little the cult of the "great god Smatter." Teachers were induced to collect the greatest number of students they could gather together; and to teach them in such a way that they were enabled to pass a not very difficult examination, without acquiring any genuine knowledge of its subject. In a great number of cases all the students did was to acquire a smattering of some branch of science, which, perhaps fortunately for themselves, they very rapidly forgot. But, on the whole, the disadvantages of the system were more than counter-balanced by its successes. The ultimate result of the work of the Department has been to cover the country with a network of schools, some of which, aided by local effort, have attained the highest class, and to provide a means by which the poorest student of ability may obtain a scientific education, and the opportunity of starting on a scientific career. There are not wanting, among our more distinguished professors, some who began their training in one of the Department's classes. The Royal College of Science at South Kensington, intended for teachers, but available also for students who may never intend to become, or who have abandoned the idea of becoming teachers, ranks with the best schools of science in the country. Its professors include many of the best known of our scientific men. And the result of the whole system is that an elementary school-boy entering a science class, and thence perhaps passing to one of the provincial colleges, may eventually enter the College at South Kensington, and obtain as good scientific teaching as the country can provide.

The demand for Technical Education came a little later. The discovery that the manufacturers of other countries were better instructed in the applications of science to industry than those of Great Britain led to the appointment, in 1881, of an important Royal Commission, which investigated the technical schools of Germany, France, Switzerland, and elsewhere, and embodied the results of their investigations in a very valuable Report. The Society of Arts established, in 1873, a series of technological examinations—examinations in certain selected branches of scientific industry—which were in some sort a supplement to the examinations in pure science held by the Government Department. There was, however, no payment on results for these examinations, which were purely of a voluntary character, and they attracted but a very small number of candidates. A few years later, however, the ancient companies of the City of London, survivals of the mediæval Guilds which regulated the trades and handicrafts of the City, and have retained considerable wealth, saw in the demand for technical education a means of employing their accumulated funds, and, by once more associating themselves with the trades with which they were nominally connected, of justifying an existence now become almost an anachronism. They, in 1879, took over the technological examinations of the Society of Arts, and by offering payments to teachers on a scale similar to those made by the Department, induced the formation of classes, and obtained a considerable number of candidates. These examinations, under their new administration, have flourished so well that for some years past they have been enabled to dispense with any payments, and yet they had last year as many as 13,000 candidates who entered for the examination. They also built and endowed at South Kensington, in close proximity to the Royal College of Science, an institution for the teaching of science as applied to industry, and besides this they established what may be termed trade schools, to act as feeders to their central institution. Thanks to the munificence of the Guilds, and the judgment with which their money has been expended, the state of technical education in England is now fairly satisfactory. The higher technical education is good, though not as good as at the better endowed schools on the Continent; while there are certainly more opportunities in England for the workman to obtain scientific knowledge in the basis of his craft, if he cares to do so, than in any other European country.

Next, as the demand had arisen in succession for scientific and for technical education, so now there

has been raised an outcry for commercial education. Our merchants in London, and the other great cities of industry, were struck by the fact that many young foreigners, principally Germans, have been willing to come over and accept lower wages than would be paid to much inferior English clerks. They did not at first quite realise the fact that many of these young men were the pick of their class, that they came to England, not because there was no room for them in their own country, but with the object of acquiring foreign experience, as well as a foreign language, that in the case of many of them pay was but a secondary consideration, and that as soon as they had acquired the necesary knowledge, they were quite ready, either to go back to their own country, or, if they remained in England, to set up as rivals of their employers. The advent, however, of this class of foreign clerks drew attention to the fact that they were far better educated for commercial purposes than young men of a similar class in our own country. This, and the fact that England is now feeling keenly the commercial rivalry of other nations in fields which she has so long regarded as her own peculiar property, led to a serious demand for improved commercial education. In this demand, probably those who made it did not very clearly realise themselves precisely what they wanted. They had impressed upon them the fact that the lads and young men who were entering their offices were, as a class, but poorly instructed, as compared with a like class in continental countries; they did not stop to inquire whether the deficiency was in quantity or quality, and they cried out for a reform in teaching methods, declaring that some new provision of commercial education was required, without saying —indeed, without knowing—what they meant by commercial education.

At the present time, as may be gathered from the preceding short summary of our English educational methods, the rank and file of our commercial classes are drawn from the general middle-class schools, or— as regards the lower grades—from the elementary schools; while our upper commercial classes—sons of men of business, or of professional men, whose education can be carried on later in life—receive the ordinary grammar or public school education of English lads—in some cases completed at the universities. The former class leave school at fourteen or earlier, with little knowledge of anything but reading, writing, and elementary arithmetic. They acquire by practice a knowledge of the business methods of their particular trade and industry, and as a rule turn out sufficiently capable servants. The more intelligent advance to higher positions. The rank and file carry on the routine tasks with which constant practice has made them familiar.

There is one question which cannot be neglected in the consideration of any department of English education—that is the question of athleticism. I do not think that persons of other nationalities realise to how great an extent our English schools are dominated by the love of sport and games. To a large proportion of our *profanum vulgus* the two universities of Oxford and Cambridge are not primarily "seminaries of sound learning and religious education," but two organisations which contend annually in a boat race. To the fashionable world of London our two greatest public schools—Eton and Harrow—are most in evidence when the boys come up to a well-known cricket-ground in London for their annual cricket match. At all our great public schools the heroes of the playing-fields form the dominant element in the school. It is said that no young master can hope for a situation in our upper class secondary schools unless he is an athlete as well as a scholar. He must have taken honours, not only in the schools, but on the river, or in the cricket-ground. The same influence extends through all our upper and middle-class schools, and affects our young men after they have left school. Our large business houses have their cricket clubs and their athletic clubs. The most recent polytechnics are not unmindful of the old Greek system of education, which comprised not only μουσική but γυμναστική, and they provide for physical as well as intellectual development. The champion in our amateur walking contests is at the present time a student in the London Regent-street Polytechnic.

As so much time and thought is devoted to the development of the body, it cannot be denied that the development of the mind, if it does not suffer, is likely to be delayed. I believe that on account of our devotion to athleticism, we are, to a large extent, regarded as barbarians by educational critics of other countries, and this feeling is not without its exponents among ourselves. I have myself no sympathy with such critics, for I believe that combined mental and physical training turns out a better product than mental training alone. But while I would ask educational authorities to remember that young folk have bodies to be trained as well as minds, I do not advise them to forget that they have minds as well as bodies. It must, I fear, be admitted that the cult of athleticism is carried to excess in our leading schools and our older universities. I would, however, point out what I do not think has hitherto been considered in this connection, that in most European countries every man is compelled to pass a certain portion of his life in the army, and that the drill and exercise to which he is subjected must, to a large extent, form the equivalent of our voluntary English sports and games. Compulsory military service, too, affects all classes alike, whereas in England the classes whose children fill the elementary schools have no such useful physical training, and are, I fear, beginning to show the want of it, now that they tend more and more to seek occupations not involving manual labour. I would also point out that there seems to be a tendency, at all events in France and in America, to encourage physical exercises in schools. In America, to my own knowledge, there has been a great change in this respect during the last few years. But, on the whole, it must be remembered in

comparing the educational condition of the young English clerk with his French or German colleague that the latter has probably devoted more time to his mental development, and is, besides, less apt to devote his attention to athletic amusements, instead of to the duties of his business. Such amusements too often form the real interest of his life, instead of its relaxation.

A few years ago it might, I think, be said with truth that there were no purely commerciall schools or institutions in the kingdom. Some have lately been established—of these the most promising is the London School of Economics, in which instruction is given in matters bearing on the higher commercial education—economics, statistics, political science, commercial law, &c. There have, however, for a long time been evening schools at which those already engaged in business can continue their education. Although these classes do not owe their origin to the science school of the Department, it is, I think, owing to the development of these latter schools that there has been a similar development in classes for teaching subjects of a commercial character. The science schools, aided by the Government grant, added to their courses of instruction classes for the teaching of modern languages, book-keeping, shorthand, mathematics, and the like; while some of the older so-called mechanics' institutions, founded early in the century for the dissemination of popular knowledge and the improvement of the working-classes, were enabled, by the establishment of the science classes and the consequent money which they earned, to enlarge their operations, and to carry on more effectively than they hitherto had done their classes for teaching subjects other than those subsidised by the State. Further than this, day classes have been added. Thanks to private liberality. to the application of ancient endowments, and to the judicious application of the revenues provided by the State, there are now a great number of teaching centres where instruction is given in science, languages, art, and general and commercial education. In London, a number of such institutions have existed for some time past, and their number has recently been largely increased by the formation of several so-called polytechnics. The instruction is principally given in the evening, but most, if not all of them, carry on classes during the day also.

A few years ago, a great impulse was given to the development of these institutions by the fact that Government was able to assign to the County Councils (provincial authorities for local administration), certain funds to be employed for educational purposes. To assist the application of these funds, and to encourage their proper use, the Science and Art Department was also empowered to add to the list of science subjects, by teaching which its grants could be earned, many technical and commercial subjects, including in this latter category shorthand, book-keeping, &c., as well as foreign languages.

As far back as 1856 the Society of Arts established examinations in general knowledge, conducted from a single centre simultaneously all over the kingdom, the object of these examinations being to encourage the formation of classes among the workmen's institutions then existing, and to afford the students of such institutions a means of testing their knowledge. It was on the model of these examinations that the examinations of the Science and Art Department were founded. The Society of Arts system has undergone various modifications, but for some years past the subjects with which they deal have been purely commercial. They include shorthand, book-keeping, type-writing, commercial geography, foreign languages (the examination in these is of a commercial, not of a literary character), &c. The students in the evening classes, accustomed to the periodical examinations of the Department, welcome those of the Society, and are encouraged by their teachers to enter for them, although there is no profit to be earned by their doing so. The fees are kept at the lowest possible amount, in fact, the examinations are now barely self-supporting, and, until the last few years, were conducted at a loss. During the present year, 10,500 candidates have been examined at 257 centres, situated in various parts of the United Kingdom. The examinations are in separate subjects, and a candidate can obtain a certificate for passing in a single subject. This method has its drawbacks, but it is found to suit the class which it is intended to assist. The attempt mas made, some years ago, to substitute for the separate certificates a certificate in commercial knowledge, to obtain which it was necessary to pass in certain specified subjects, but the attempt proved unpopular, and the attempt was abandoned. A student prefers to come up for one year, perhaps, in French and in Book-keeping, and having a certificate in each of these, he will go in the succeeding year to German and Shorthand. A vast majority of these examined are of the commercial class—clerks, book-keepers, typists, shorthand writers, salesmen, and shop attendants, or young people preparing for such employment.

(To be continued.)

Correspondence.

PROTECTION OF INVENTIONS AND TRADE MARKS IN EX-SPANISH COLONIES.

According to advices just received from Washington, I learn that a circular has recently been issued by the United States War Department dealing with the above subject. The following particulars may interest your readers.

In territory subject to military government by the military forces of the United States, owners of patents, including design patents which have been issued or which may hereafter be issued, and owners of trade marks, prints, and labels duly registered in the United States Patent-office under the laws of the United States relating to the grant of patents and to the registration of trade marks, prints, and labels, shall receive the protection accorded them in the United States under the said laws; and an infringement of the rights secured by lawful issue of a patent or by registration of a trade mark, print, or label, shall subject the person or party guilty of such infringement to the liabilities created or imposed by the laws of the United States relating to such matters: provided that a certified copy of the patent or of the certificate of registration of the trade mark, print, or label shall be filed in the office of the Governor-General of the island wherein such protection is desired; and provided further, that the rights of property in patents and trade marks secured in the islands of Cuba, Porto Rico, the Philippines, and other ceded territory, to persons under the Spanish laws shall be respected in said territory, the same as if such laws were in full force and effect.

REGINALD W. BARKER.

56, Ludgate-hill, E.C.
May 18, 1899.

General Notes.

ROYAL INSTITUTION.—At a General Meeting of the Members of the Royal Institution, held on the 22nd inst., the following foreign scientific men were elected Honorary Members, in commemoration of the Centenary of the Royal Institution, which will be celebrated on the 5th, 6th, and 7th of June next:—Professor S. Arrhenius (Stockholm), Professor C. Barus (Brown University), Professor H. Becquerel (Paris), Professor G. L. Ciamician (Bologna), Professor N. Egorof (St. Petersburg), Professor A. P. N. Franchimont (Leiden), Professor A. E. Gautier (Paris), Professor H. G. Kayser (Bonn), Professor W. Körner (Milan), Mr. S. P. Langley (Washington), Professor G. L. Van der Mensbrugghe (Ghent), Professor A. A. Michelson (Chicago), Professor H. Moissan (Paris), Professor R. Nasini (Padova), Professor W. Nernst (Göttingen), Professor W. Ostwald (Leipzig), Dr. E. Solvay (Brussels), Professor R. Thurston (Cornell), Professor E. Villari (Naples), Professor J. L. G. Violle (Paris), Dr. E. Ador (Geneva), Dr. L. Bleekrode (The Hague), Professor J. S. Ames (Johns Hopkins University), Professor G. F. Barker (Philadelphia), Dr. O. Liebreich (Berlin), Dr. W. L. Wilson (Washington).

MEETINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MAY 30.—"The Revival of Tradesmen's Signs." By J. STARKIE GARDNER, F.G.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

JUNE 1.—"The Port of Calcutta." By Sir CHARLES CECIL STEVENS, K.C.S.I., late Acting Lieutenant-Governor of Bengal. The EARL OF ELGIN AND KINCARDINE, K.G., G.C.S.I., G.C.I.E., will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 29...Surveyors, Great George-street, S.W., 3 p.m. Annual General Meeting.
Geographical, University of London, Burlington-gardens, W., 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m. Mr. T. J. Bailey, "Planning and Construction of Board Schools."

TUESDAY, MAY 30.. SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. J. Starkie Gardner, "The Revival of Tradesmen's Signs."
Royal Institution, Albemarle-street, W., 3 p.m. Professor W. J. Sollas, "Recent Advances in Geology." (Lecture III.)
Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.
United Service Institution, Whitehall, S.W., 3 p.m. Major-General Sir W. F. Gatacre, "Hill Fighting and the best Mode of Training for the same."

THURSDAY, JUNE 1 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir Charles Cecil Stevens, "The Port of Calcutta."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. W. Botting Hemsley, "The High Level Plants of the Andes as illustrated by the Collections of Sir W. Martin Conway, Mr. Edward Whymper, and others." 2. Sir John Lubbock, "Some Australasian Collembola."
Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. Popplewell Bloxham, "The Hydrosulphides, Sulphides, and Polysulphides of Potassium and Sodium." 2. Dr. Sydney Young, "The Relative Efficiency of Various Forms of Still-head for Fractional Distillation." 3. Dr. J. N. Collie and Mr. Thomas Tickle, "The Salts of Dimethylpyrone and the Tetravalence of Oxygen."
Royal Institution, Albemarle-street, W., 8 p.m. Prof. L. C. Miall, "Water Weeds." (Lecture II.)

FRIDAY, JUNE 2...Geologists' Association, University College, W.C., 8 p.m.
Philological, University College, W.C., 8 p.m.
Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, JUNE 3...Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. F. Jacques, "The Music of India and the East, and Its Influence on the Music of Europe." (Lecture III.)

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FRIDAY, JUNE 2, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

INDIAN SECTION.

Thursday, June 1, 1899; the Earl of Elgin and Kincardine, K.G., G.C.S.I., G.C.I.E., in the chair.

The paper read was "The Port of Calcutta," by Sir Charles Cecil Stevens, K.C.S.I., late Acting Lieutenant-Governor of Bengal.

The paper and discussion will be printed in a subsequent number of the *Journal.*

APPLIED ART SECTION.

Tuesday, May 30, 1899; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., in the chair.

The paper read was "The Revival of Tradesmen's Signs," by J. Starkie Gardner.

The paper and discussion will be printed in a subsequent number of the *Journal.*

CONVERSAZIONE.

The Society's *Conversazione* will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, 20th June. The reception by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman, and other members of the Council, will commence at 9 p.m.

The following portions of the Museum will be open:—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery; on the First Floor—the East and West Corridors.

A selection of music will be performed by the String Band of the Royal Artillery in the Central Hall, and by the Red Hungarian Band in the Bird Gallery, commencing at 9 o'clock.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These tickets will be issued shortly. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the *Conversazione.* On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary) or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

The entrance to the Museum is in the Cromwell-road. Carriages must enter the grounds by the east gate and leave by the west gate. The cards must be given up on entering the Museum.

Visitors arriving or leaving by either of the Metropolitan Railways will be allowed the use of the District Company's Subway, which leads from the South Kensington Railway Station direct into the grounds of the Museum.

Fuller particulars as to the musical and other arrangements will be given in the Programmes which will be distributed on the evening.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 16, 1899; Sir James Linton in the chair.

The paper read was—

PICTURE FRAMES.

By I. Hunter Donaldson.

We cannot to-night occupy much time in considering the origin or antiquity of picture frames, but may refer to some of the oldest known to us. The frescoes of Pompeii, still in parts perfect and beautiful, offer numerous examples of framing designed by the artists for the isolation of their subjects and the enhancement of their effect; these being the primary objects of all such framings.

At the British Museum Dr. Murray kindly pointed out their oldest frame, of about the 2nd or 3rd century of our era; it is of a hard wood like beech, of what we know as the "Oxford" pattern, with a marginal 1-inch flat, a groove to receive glass, and cord to suspend it by the corners. The panel had a portrait of encaustic, now nearly obliterated. I also saw an engraving of a Pompeian studio, in which a lady artist is sitting with a similar frame and portrait in it, near her. We then went to the finely preserved mummy from Hamara in the Fayoum, of a young woman once of much beauty, whose portrait on a 12 by 9 panel is at the head, with a framing of many folds of the cerecloth, which is ingeniously swathed so as to form a geometrical pattern all over the body. I am told that poor Egyptians who could not afford to have such portraits painted expressly for their lost ones, used to buy, from stocks of ready-made portraits, such as most nearly resembled the deceased, and when the swathing cloth decayed, such portraits were hung up as pictures. It was a custom of the Romans to have upon round, or shield-shaped wood, portraits called "imagines" of their celebrated dead, modelled in coloured wax, to carry these in the funeral processions, and afterwards to suspend them in the houses.

We know that the ancients painted in every style of art, excelling in all, and though Pliny says that "the greatest glory was obtained by easel pictures," he gives, as another reason for preferring them, the fact that paintings upon the actual walls cannot be saved in case of fire. We read that Cicero sent large sums of money to his friend Atticus, to buy pictures in Greece, for decorating his villa at Tusculum, and artists of distinction, like Polygnotus, must have been well aware of the importance and effect of suitable frames for their masterly works.

That no examples of beautiful ancient frames can now be found is not surprising, for we are told that the anti-pagan zeal of the early Christians led them to destroy everything they could which was pagan, however artistic; they used to put ropes round the marble necks of the almost divinely-beautiful Apollos and Venuses, drag them into the open, try them in public like criminals, find them (of course) guilty, and then pound to dust statues by men whose names we reverence to day. Thirteen hundred years later a religious zeal, not according to knowledge, led Cromwell's troopers to stable horses in Worcester Cathedral, whilst money was actually paid for the destruction of stained glass which we should now consider priceless. We do, however, owe to the "Protector" the purchase of Raphael's cartoons for the nation. I mention this because it explains the reason why no frames have been handed down to us by which the subject can be illustrated.

There is not time to include in this paper frames made for predellas or altar pictures, those for the exquisite Venetian and other mirrors, or those designed for the sculptural works of such artists as Della Robbia, Donatello, and Sansovino, numerous and beautiful as they are; of these fine examples exist at South Kensington, in the Wallace collection, and elsewhere. Of the vast number of designs made to surround portraits engraved in the 16th, 17th, and 18th centuries. some prints, kindly lent by Mr. George Clulow, are hung here. And we are indebted to Mr. Hugh Stannus, always active in the interests of art, for the photographs which show framings in panels, walls and ceilings of the most celebrated Italian buildings.

Persons who will take the trouble to examine the frames used by the older English masters in oil and water colours, will notice the poverty of design and the want of taste of most of them. This was felt so much by the leading artists in the sixties, that they were led to make great improvements, and, *àpropos* of the common-place expression, "What a beautiful frame," uttered sometimes by those incapable of judging the merits of a picture, two articles appeared with illustrations in *The Architect*, exactly thirty years ago. These were written by Mr. Phené Spiers, Master of the Architectural Schools of the Royal Academy, himself an accomplished artist. He said, "In a frame lies a not inconsiderable portion of the completeness of a picture, and there are fortunately a few painters, Mr. Leighton notably among them, who have long recognised the fact that their powers of imagination and composition ought not to terminate with their canvas." Mr. Spiers ably criticises the frames in the Exhibition of the Academy in 1869, and we shall have details of those frames on our screen, with his remarks for our information.

These were frames drawn with exceeding care by Mr. Phené Spiers, 30 years ago, and they were reproduced in *The Architect* with criticisms more lengthy than those I have referred to. For the benefit of those interested in frames I may say that some of the designs shown this evening will be reproduced in the

Journal of the Society of Arts, and I hope they will be found of use, for in the exhibition now coming on there are not many frames showing such artistic beauty as these, and very few equal to them in their general treatment. In the Academy there are many pictures with frames like No. 174, but the objection to the frame is this, that the large mould is close to the picture. The effect of that is to lessen the importance of the picture.

110. Mr. Poynter.—"The close juxtaposition of the pateræ suggests a running border; they should not have been emphasised at the corners."

117. French.—None in the Exhibition giving more effect to the picture.

154. Mr. Alma Tadema.—A Belgian frame, somewhat similar, with burnish brought into the ornament, and not, as in the English, confined to the lines.

421. Mr. Alma Tadema.—Shows careful attention to style, the large Cavetto member making it rather less happy than 154.

81. Mr. Richmond.—Good, but not his design, too free use of the figures of devils.

174. Mr. Portal.—French, showing influence of Greek art more than any other frames, except those of Mr. Leighton.

432. Mr. Yeames.—Vigorous and bold, appropriate to the period of picture; improved by a deeper set-back and broader margin of plain.

99. Mr. Sandys.—One of the most original; the simple Gothic moulding and contour accord with style of picture, splayed surface at bottom giving solemnity to the subject.

This is mediæval in its treatment; the lower part is flat, all the mouldings terminate upon the flat, and for paintings representing ecclesiastical subjects such a frame would be particularly appropriate. You will find in South Kensington and other galleries altogether appropriate frames for religious subjects. In the Academy there is one flagrantly wrong.

272. Mr. Armytage.—Egyptian ornament, contour very good, accessories in keeping with subject.

705. Mr. Leighton.—Refined, showing knowledge of the best and most subtle forms of Greek art, the effect of painted ornament on the gilded surface of the frame very good, and might with advantage be more extensively employed.

The effect of painting upon the gold has been altogether disregarded in this country. If you go to Florence you will see a number of frames painted in a charming manner.

864. Mr. Leighton.—Well-studied, but less good, rather heavy, and tending to convexity in contour of mouldings

This is a very elaborate frame; it must have taken a great deal of time to design, but the general effect is not at all pleasing. The straight line is very injurious to a picture, there is no stereoscopic effect which a frame should give to the picture.

483. Albert Moore.—Simple and effective.

699. Albert Moore.—Sparkling and delightful.

485. Frank Walker.—Original, but section too straight.

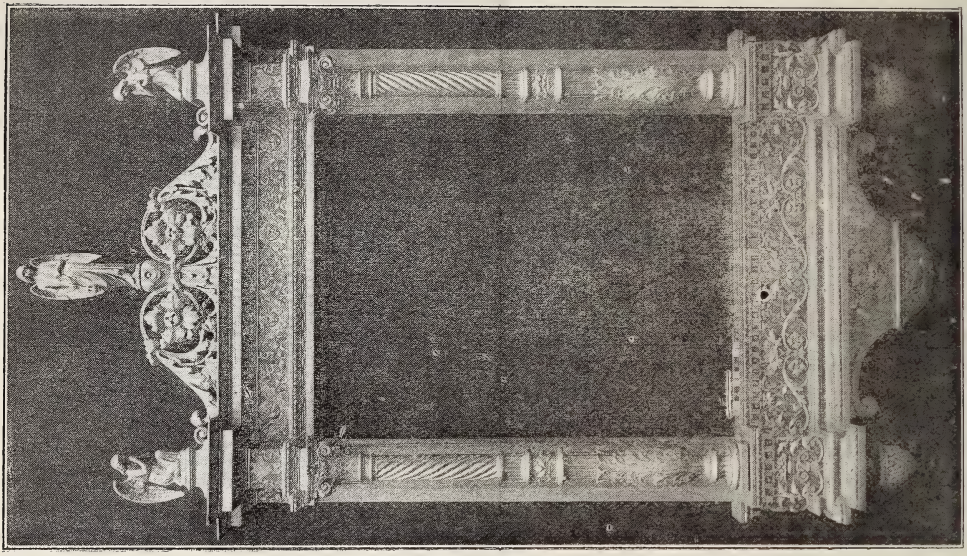
730. Mr. Prinsep.—Based on Leighton's, but not Greek.

736. Mr. Graves.—Very good in design, and well modelled.

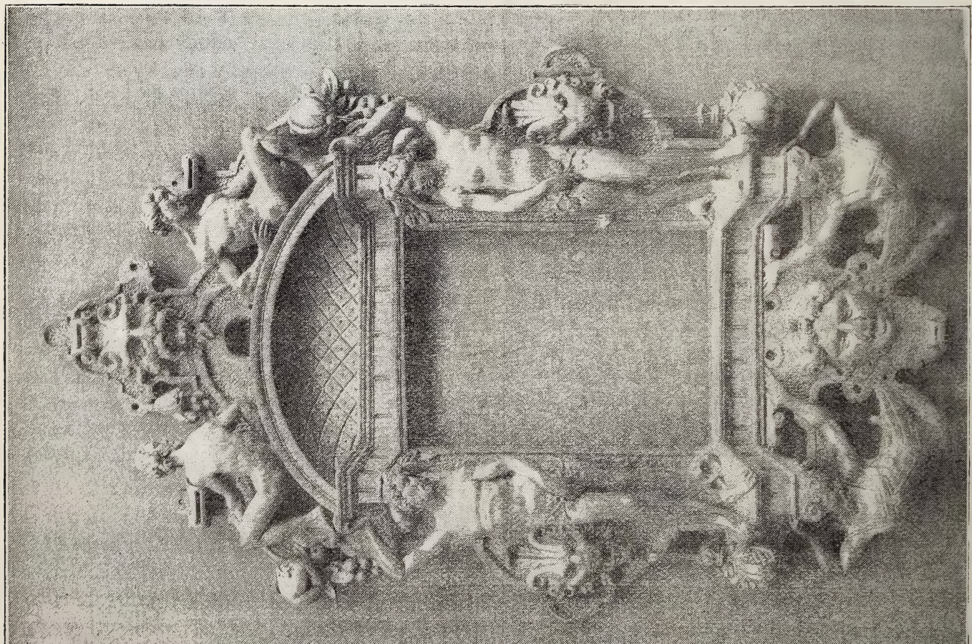
Fourteen years ago, Mr. W. R. Lethaby, in an able paper, drew attention to the poverty of design in frames then exhibited, with some remarks to which I shall refer later. Before this time much attention had been given by foreign artists to their frames, which were not unfrequently designed under the inflnence of the best Italian period, some examples of which will be shown. We are justified in expecting that since the year 1869 an advance should be seen in the designs of frames, especially by our principal artists, and some of the more recent ones will be displayed. We may soon hope that when the expression "What a beautiful frame" is heard, it may be found to proceed from a person whose cultivated taste and sense of beauty apply equally to the work of a true artist in his picture, and in the frame he has designed for it.

I do not think it can be claimed for the frames in this year's Academy that they show any advance in design upon those of thirty years ago; some of the largest are defective in architectural detail, and some have large, busy, obtrusive mouldings close to the pictures; there is a noticeable display of old frames, for which there is now great demand, and for the first time we see a number of gilt frames toned almost to the colour of wood; some of the most grandiose lack the refinement of those of '69, and although there is undoubtedly more variety than formerly, there appears to be less purity of taste. The true relation of a frame to a picture has probably never yet been the subject of a lecture to students, and the very alphabet of this phase of art is unknown to thousands of them.

I will refer to four frames. I assume my hearers have been to the New Gallery and seen the work of Mr. Holman Hunt, "The Miracle



Italian Frame, Sixteenth Century.—South Kensington.



Italian Frame, Sixteenth Century.—South Kensington.

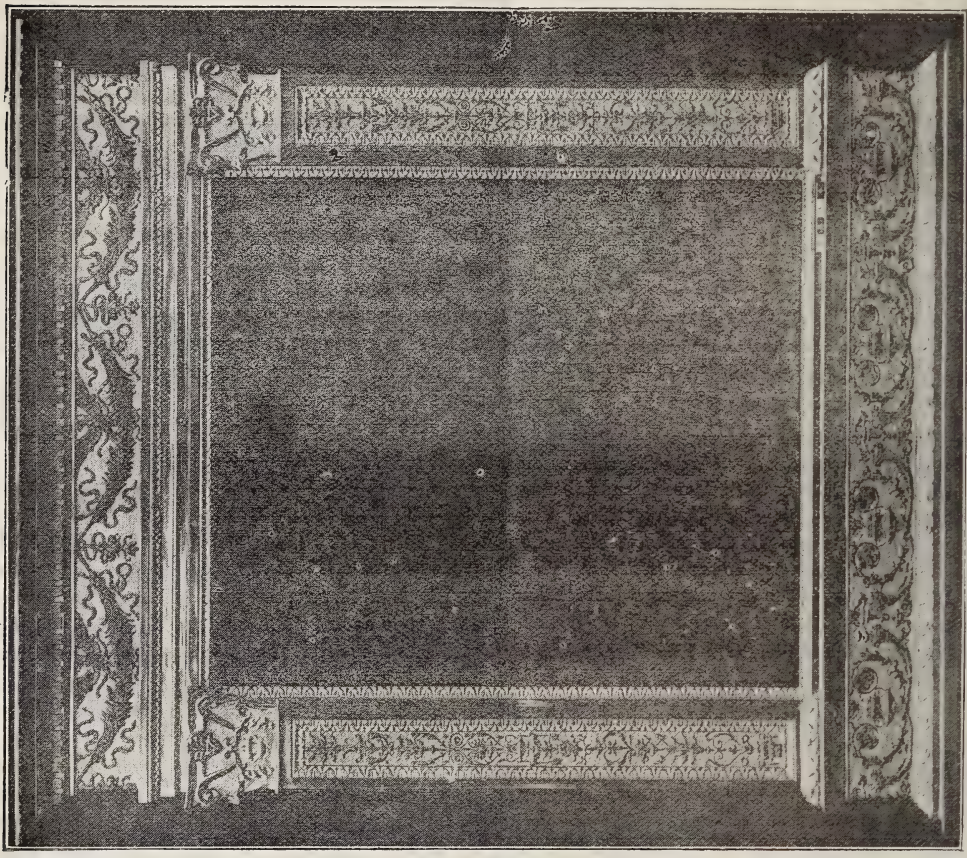
of Sacred Fire," in the Church of the Sepulchre at Jerusalem. Mr. Holman Hunt has put fourteen figures in groups on the frame with a seven-branch candlestick in the centre, and he has modelled all these in gesso, the frame is gilt and it requires toning, but apart from that it is interesting. The curious thing is this, he has made a pediment and rested it, without any frieze, on two pilasters. He has ignored, in the most flagrant manner, the ordinary principles of architecture. In many frames at the Academy there are obvious departures from the recognised principles which govern such work. My friend Mr. Chapman, from Paris, sent me the *Journal des Débats*, in which a picture by M. Roll is mentioned. The subject of it is "Laying the First Stone of the Bridge of Alexander III. in Paris." Mr. Michel, the critic, says:—

"The frame is a great low relief of wood with unequally projecting allegorical figures; below is a Siren advancing from the prow of a barque, the oars of which seem to come from the forepart of the picture above, rays of light appear to drive the nocturnal owl into a corner; on the sides are Peace, Abundance, and the Arts. This frame is a work of much pride to the distinguished artist designer."

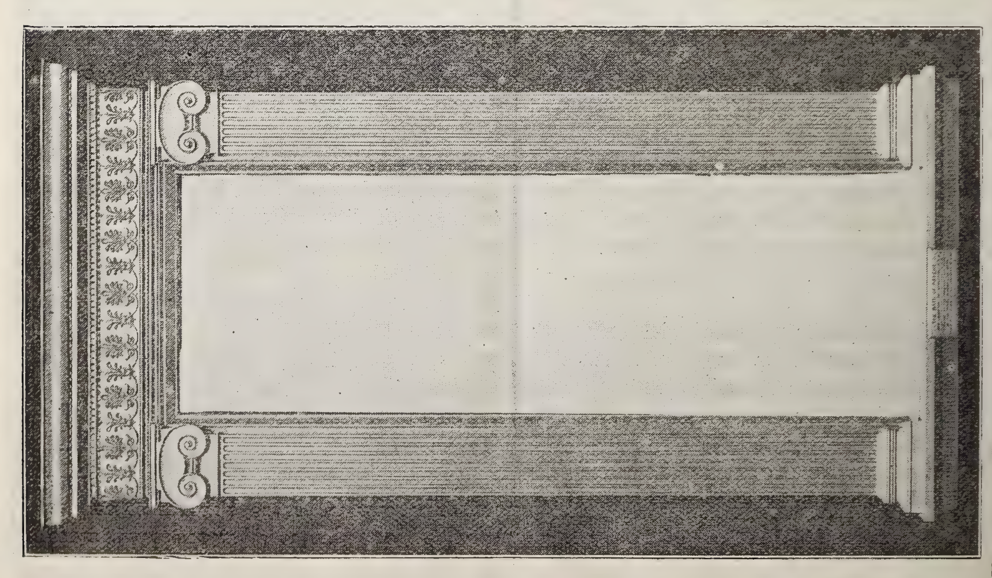
The frame which can perhaps take the first prize for eccentricity, at all events in the English galleries, is the frame designed by Mr. R. Machell, R.B.A., for a picture called "Parsifal." It must have been the subject of immense care and study by a highly intelligent man, and, no doubt, a true artist. I think you will agree, on looking carefully at it, that you would be sorry to live with it, and, secondly, that it is the most ambitious and least successful of frames this year. Incidents and characters of the subject are carved on the decorated frame, the centre being occupied by "Parsifal" raising the cup of the Holy Grail. In the picture of "Psyche's Bath" Lord Leighton has carried some details of the frame into his painting, but Mr. Machell has deliberately carried a large part of his subject into his frame; happily he is in this alone among English artists.

Not a little of the effect of picture-frames depends on their being hung in a suitable light; a side light in a too projecting frame may cast an injurious shadow. Not long ago I saw an exquisitely carved frame and an equally beautiful panel in low relief, placed between the two windows of a room; the work cost £1,200, and was practically lost for want of the side light which all such works should have. *A propos* of this, we may recall the story of Douglas Jerrold and Albert Smith going to a picture gallery. On the stairs was a mirror, standing before which Albert Smith said, as he looked into the glass, "Ah! my boy, there's a picture!" "Yes," said Jerrold, "it wants hanging!" So, when we have a good picture in its proper frame, we must not forget that, as Jerrold said, it "wants hanging," and that carefully, in justice to the artist.

We must all have observed the great value of black in frames, especially in works of the Dutch and Spanish masters, sometimes with bands of tortoiseshell or fine lines of gold, with the varied and very characteristic wave mouldings which had their origin in Spain, and were adopted in Italy and Holland, the Dutch artists especially recognising the suitability of such framings for their paintings. Mr. Watts was among the first to observe this, but, curiously enough, the least happy use of black is perhaps in the large works of Mr. Watts at the Tate Gallery, where, at a little distance from them, broad bands of gold separate, instead of combining, the frames and pictures; this rarely occurs in the foreign examples. There are some good black and gold frames in our national galleries, and, as we know, in the mezzotints of Bartolozzi, Ward, and others. Black behind the glass, with gold lines and delicately-moulded gilt frames, gives great charm to the works of their time. The neglect of proper framing by early and very able masters in water colour is surprising, in view of the 17th and 18th century framing known by them, some of their finest works being injured by mean and meaningless surroundings. Men of acknowledged eminence, even in our own day, have not troubled themselves to consider the art of framing. It will, I think, be a matter of surprise that our noblest writer and critic, Mr. Ruskin, has not yet treated this subject in any of his beautiful works, and in many of those of authority upon painting which I have consulted, no reference to frames is made. I do not absolutely affirm that Ruskin never made such a reference, but I have spent a whole day in going through his works, and I could not find a single reference to picture frames, which is a remarkable thing. The most noticeable of English designers of frames is Grinling Gibbons, born in London in the latter half of the 17th century. He was recommended by Evelyn to Charles II., who commissioned him to execute the ornamental carving for the Chapel at Windsor; he also did the foliage and festoons of the Choir of St.



Italian Frame, Sixteenth Century.—South Kensington.



Frame of "Bath of Psyche" (Leighton).—Tate Gallery.

Paul's, the baptismal fonts in St. James's, Piccadilly, and works at Petworth, Burleigh, and Chatsworth, Hampton Court, &c. His talent was wasted in carving pens and feathers that were mistaken for real ones, flowers which used to move on their stems by the air, &c. We shall all agree, probably, in thinking such work, however full of loving labour, unsuitable for picture frames, to which it has been applied; the modern English housemaid would soon reduce much of it to matches. On my last visit to Florence I found a fine example of Gibbons' carving in a public museum; and a very ambitious work in South Kensington Museum is his "Stoning of St. Stephen," probably copied from a painting. With some defects of perspective, it is not "the highest form of decorative design," in which Mr. Ruskin said, twenty years ago, "the English will never excel," but the rare sense of beauty in natural objects, the manipulative skill, and the tireless industry of Grinlin Gibbons will always secure a place for him in the annals of art as our most original frame maker.

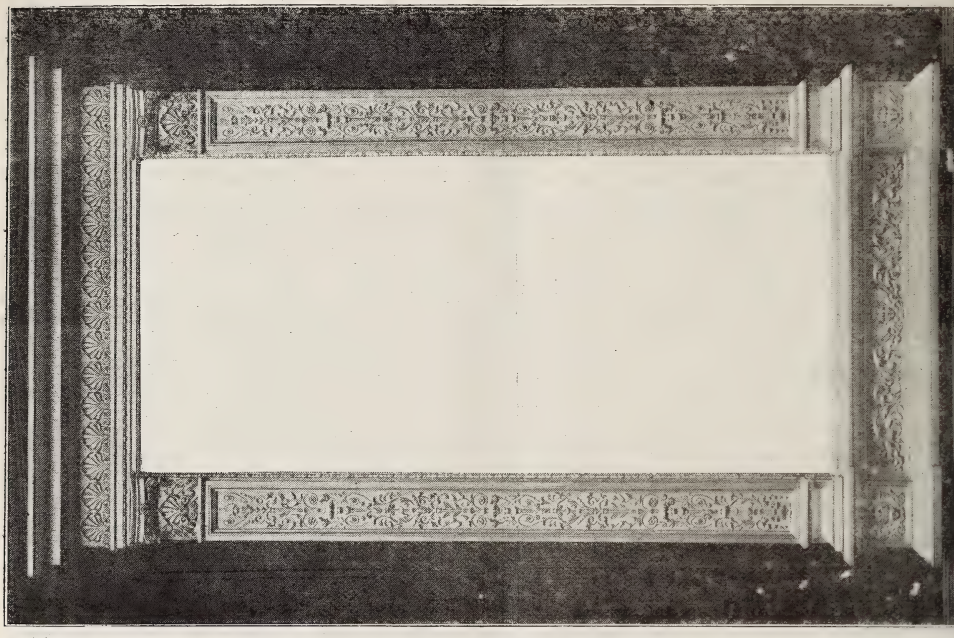
As miniatures have always to be examined near to the eye, the effect of any mode of framing has not seriously to be considered; the oval form is obviously the best and most generally used, but the marked advance of this form of art has led to the adoption of square or oblong frames, generally in ormolu; these are not, however, quite within the scope of our paper. In nearly all the oval frames there is a gold moulding round the picture, and that flat moulding is burnished highly so that it is difficult to look at the picture without the glitter of the thing coming to the eye, and it impairs the work. Now, whatever our objection may be on patriotic grounds to things "made in Germany," it is only just to admit that we owe to that country the introduction of highly-finished frame mouldings in colour and gold, well suited for drawings, engravings, and the many and beautiful developments of photography; we have "bettered their instruction" with our framings in light and dark oak, walnut, and the shades of stained-green ash and oak which, with delicate gold lines, give such charm to these latter day works.

The Americans, too, have entered this field, and now Messrs. Graves and Co., of Pall Mall, have frames of their make decorated in the "Adam" and "Empire," and other styles, with ornaments laid in gesso, on stained-maple, walnut, oak, in tinted ivory, on neutral green, in bronze, on black, &c., of great variety, and with harmonious effect. The style employed has perfect examples all around us, well-known to art lovers, but it has remained for our cousins to glean the field which was sown here and abroad a century ago, and the mezzotints, now so much sought, are charming in these surroundings. The "Autotype" Company have courteously sent some specimens of their less elaborate, but highly artistic, frames, and I cannot imagine any more suitable than these for the charming photographs with which they have made us so familiar.

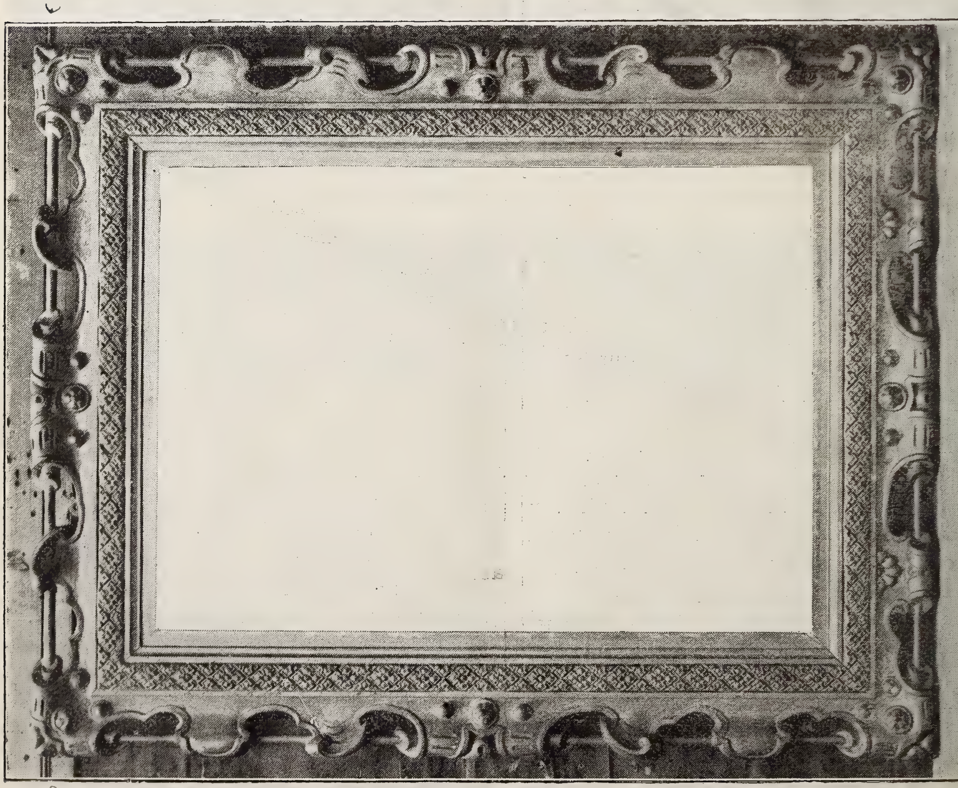
[Having called attention to six frames which Mr. Donaldson said were admirably adapted for the works they surrounded, he drew attention to some frames lent by Messrs. Goupil and Co., which he said represented what gilt frames French taste preferred. English frames designed by the artists were of more refined character, and had more appropriateness in connection with the pictures. He next referred to some wood frames made in Florence, and drew particular attention to the extreme care taken to make the moulding intersect at the corners. After describing some slides, kindly lent by the authorities at South Kensington, Mr. Donaldson proceeded.]

The Florentine modern frames of carved wood, as you will see, have delicacy and beauty of detail; more elaborate and, necessarily, more expensive, they are of great technical merit, and are superior to any machine-made ones. Messrs. Goupil and Co., of Regent-street, have also lent gilt frames of marked character and high finish, with some others, specially suitable for works in oil. Messrs. Gillow and Co., of Oxford-street, have kindly lent a variety of interesting and artistic frames of Italian and English make.

Now, a serious impediment to the art of frame-making is the rule of our Royal Academy not to admit any other than gilt frames. I do not know in whose prejudice or interest such a regulation originated; but I am confident of the support of able artists in saying that it should be rescinded, and that in doing so an impulse would be given to the production of truly artistic frames in gesso and in carved and decorated woods, such as we see abroad, and enormous additional effect would be secured for paintings at every yearly exhibition. I earnestly hope that the enlightened President will soon distinguish his reign by effecting this much needed reform. The beautiful and allied arts of modelling in gesso, carving, inlaying, decorating, and enamelling, would be stimu-



Frame of "King Cophetua" (Burne Jones).—Tate Gallery.



Frame of "Montacute House."—South Kensington.

lated, and public encouragement be quickly given to such a progressive measure. I invite the opinion of the Chairman with regard to that.

The material objection, I believe, is want of space, but as Disraeli said, "a difficulty is a thing to be overcome," and by excluding works of a secondary character, the experiment might be made of giving one room to some of the measureless variety of artistic frames other than gilt ones. I am fortified in this hope by the fact that for the first time we see in the Academy this year some frames with the gold toned down to almost the colour of wood in pictures on the line. That is an enormous concession to the idea that frames might be improved and other than gilt. Oh! for another Alfred Stevens who would, with proper encouragement, and with his unequalled genius, have created a school of artist framers as fine as any known to the world. We are, as Mr. Lethaby wrote in 1885, still waiting for an inspired artist worker, who must be free and with pride in what he creates; he will be, as Stevens was, familiar with the glorious old Italian methods, and will, I trust, be able to overcome the narrow-souled economy of even a Minister of public works; then, indeed, it may be possible to read of an Academy picture some such notice as this:—

"The Florentine, Simoni Ceni, wrought the carving, and Gabriello Saracini gilded it, Spinello of Arezzo did the painting in 1385."

In lending these kakemonos and frames seen, Mr. Pheni Spiers says:—

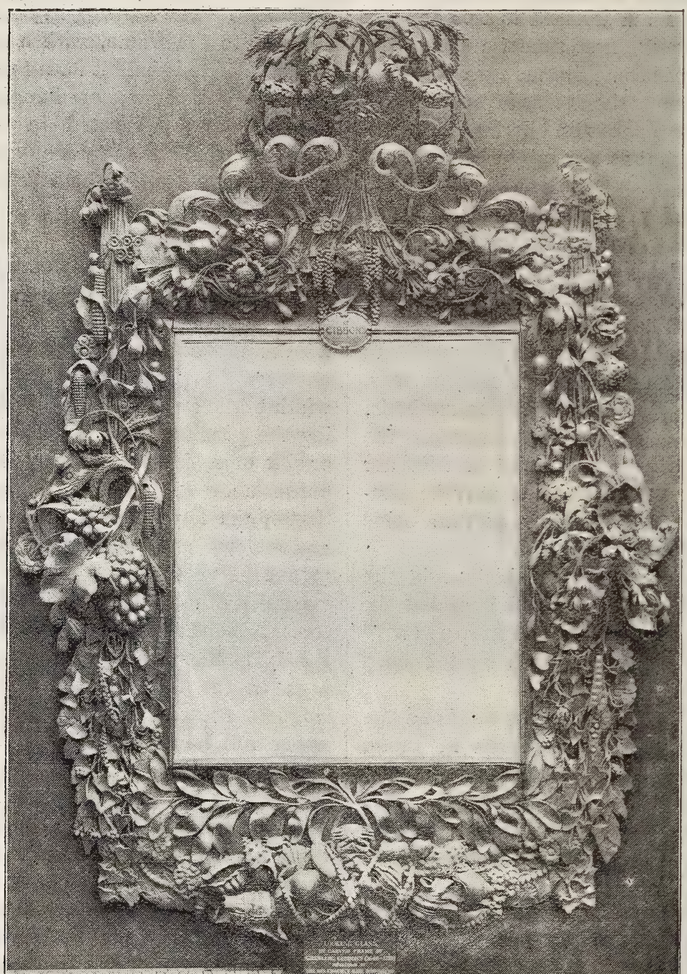
"It has struck me that a few words on the framing or mounting of drawings in Japan might not be without some interest, seeing that, until within the last few years, their methods have been carried on for centuries uninfluenced by the customs or practice of other nations.

"The Japanese have two methods: the kakemono or hanging picture, suspended temporarily only in the house or temple, and otherwise kept rolled up and preserved in the godown—the fireproof store-room; and the framed drawing hung up in the temple or carried about in processions. In the latter case the frame consists of a simple convex moulding, the width of which varies from half an inch to 6 or 7 inches, according to the size of the picture, and this moulding is painted over with body colour with natural flowers (as in one of the examples shown), or with geometrical patterns, leaving the grain of the wood as a ground, or again with sprigs, leaves, and flowers modelled in gesso (as in a recent example). Sometimes the frame is coated over with black or green lacquer, on which geometrical patterns or sprigs of plants are cut through to show the white wood. The more elaborate frames are richly decorated with avanturine lacquer, with geometrical patterns in gold lacquer, and the angles and sometimes the longer sides are strengthened and decorated with brass plaques incised with ornament. The drawing in these cases comes close up to the frame, with a border of black or red lines to isolate it from the frame.

"The kakemono, or hanging picture, is mounted and decorated in a conventional manner, which is apparently always rigidly adhered to, and which seems to have existed for centuries. The drawing is mounted on linen or paper, with a margin of from 2 to 4 inches on each side, and from 2 to 4 feet top and bottom, the lower border being about half the depth of the upper border. At the top and bottom of the drawing is a narrow strip of damask, the upper twice the width of the lower; on each side of the drawing the 3-inch margin is covered with damask or silk of a different colour, the depth of the border above (6 to 8 inches) being about twice that of the lower border. Beyond this, above and below, covering the remainder of the mount is a flowered silk or gold damask ground, with again double the depth at the top. A wood roll at the bottom, with ivory or polished ends, serving for rolling up the drawing; at the top is a semi-circular roll with rings to suspend the kakemono, From this upper roll hang two strings or tapes of the same material and colour as that of the upper mount, the original object of which is not clear, probably it is a revival of a custom of tying up the kakemono, but they are never missing. The damask or silks which form the borders are, as a rule, of much greater age than the drawing, and it is probable that the professional mounter, or perhaps the owner of the drawing supplies these materials, which are the remnants of ancient dresses either belonging to the family or acquired from actors. The latter, as may be seen from the Japanese colour prints, wear the most gorgeous dresses, and when done with, these would seem to be cut up and utilised, either for the purpose above stated, or as bags for precious pieces of lacquer, ancient tea-jars, or masks. In the two examples exhibited, one is a Buddhist kakemono, which was probably hung in a temple, the other has mounts of blue silk and

ancient damask which are really of much greater value than the drawing they frame, and of great beauty of colour."

A reference must now be made to "mounts," which are so extensively used; and of modern artists Sir Edward Burne Jones is the one who has given most attention to them. Some of his designs are marvels of elaboration, and those recently seen at the Burlington Fine Arts Club were striking evidences of his fertility and refined taste. Ruskin says, "All noble ornament is the expression of man's delight in God's work," and "genius" has been defined as "an infinite capacity for taking trouble;" these Burne Jones undoubtedly had. A short list of his frames, mounts, and grounds may be of use for future reference, and I therefore give the following examples:



FRAME BY GRINLING GIBBONS.—South Kensington.

1. Inch plain oak frame, natural colour, mount deep cream, for sketch on lighter cream ground.

2. Same frame, mount warm stone, for drawing on soft red ground.

3. Same frame, flat reeded, mount 4 inch stone, coloured with $\frac{1}{4}$ inch gold band near the deep bevel, $\frac{3}{4}$ inch band of deeper stone colour next to gold, with black fine lines ruled on the gold and to outline the band.

4. Frame 1 inch reeded walnut, mount 4 inch grey-green, $\frac{1}{4}$ inch band of gold, 1 inch deeper grey-green, then another $\frac{1}{4}$ inch band of gold, lines of black on gold bands, for drawing in pencil on light cream colour.

5. A 2 inch reeded teak, coloured oak frame, $\frac{3}{4}$ inch gilt flat, for drawing on brown paper.

6. Same frame, flat of $2\frac{1}{2}$ inch light unvarnished oak, deep bevel, near which is a fine gold line, and

another ¼ inch wide, outlined black, for a richly-coloured sketch of King Cophetua.

7. One and a half-inch flat black-polished frame, with a groove in centre, for chalk drawing on brown paper, very narrow gold flat.

8. Inch reeded light oak frame, mount light brown, very thick, and bevel cut so as to show various layers of the paper, for drawing on cream colour.

9. One and a half-inch walnut frame, flat fluted, mount 4 inch warm stone colour, with deep plain line indented near bevel, for drawing on brick-red paper.

10. Frame 1½ inch flat, with 3 grooves, green-gold, mount cream colour, band of ¼ inch green-gold near bevel, for etching in silver and gold on deep grey ground.

11. One and a half-inch frame, black, slightly elliptic, with fine gold hollows on the edges, gilt narrow flat in some cases, and in others 4 inch gold mounts, where the print or drawing is strong in colour.

12. One and a half-inch reeded walnut frame, ¾ inch mat flat, an oval inside of plain light oak, with fine gold hollow, forming sight, for portrait in black chalk on cream of light tone.

In conclusion, we may notice some changes in the last twenty years or so; a much more general employment of glass for oil paintings under suitable conditions of light, and for their protection in our climate; this has to be sometimes done, as in the Tate Gallery, by an added moulding, not improving to the frame. Another is the more general practice of framing water-colour works, as if they were in oil; this may properly be done when the colouring is of sufficient strength, and in all works there seems a tendency to employ broad bevels in place of the large gilt flats, and to allow the glass to cover them.

I submit for consideration some propositions arising from what has been said:—

1. That whilst the frame should be designed with reference to the picture; and may, in some cases, have details emblematic of the subject, it should not attract undue attention, or be eccentric; rustic subjects should not be put in highly enriched frames.

2. That the enriched mouldings of frames should diminish in importance as they approach the picture.

3. That works, not of much strength in water-colour, should have broader flats than those in oil, and not heavy gilt frames with much burnish.

4. That some pictures (like Lord Leighton's) are best without any burnish in the frames.

5. That landscape pictures, in most cases, are better in recessed than in projecting frames.

6. That the colour of a mount should not appear to blend with any part of the picture it surrounds.

7. That the gold in all frames should be toned to suit the pictures.

8. That some works have their best effect in carved wood, brown or black frames, with or without fine lines of gold added.

9. That strongly marked carved lines in frames, with corners and centres in high relief, are often injurious to the composition of line in the pictures.

DISCUSSION.

Sir George Birdwood, K.C.I.E., C.S.I., said Mr. Hunter Donaldson had provided them with a most suggestive paper on a most captivating, but most strangely neglected department of applied art. It was a department of decoration so near and handy to them all, and yet so entirely unheeded and unexplored, that his only regret was that Mr. Hunter Donaldson had not dealt with it in a more systematic and more expository manner, surveying the full extent of our ignorance of it, and all the scattered sources from which we might derive information on it; that is to say, the sources through which we might trace the evolution, or, rather, in some instances, the devolution of the various existent types of picture frames, and receive the ennabling inspirations of artistic grace for the sustenance of the refinement and elevation of their traditionary designs. The question of picture, as of sculpture,* frames, is indeed one of all but the very highest artistic importance; and painters and sculptors, truly reverent toward their art, ought to be more particular as to the framing, or other setting, of their divine handiwork, than even a writer about the binding and "forwarding" of his book. He had always taken the deepest interest in picture frames, and not only in relation to the pictures they enshrined—for the frame of a great picture should be regarded as its shrine (Latin, "scrinium") or ark, and should be designed in this devout regard—but also in relation to the position the enshrined picture has to permanently occupy; but he

* Frame is rather an awkward term to apply to a thing used merely to bind in, or enclose, any other thing, for in its primary sense it means the essential, and total fabric, body, structure, or form (as apart from the "materia prima") of things—as in these quotations:—"This goodly *frame*, the Earth"; "And spangled heavens, a shining *frame*"; "And whatever stirs this mortal *frame*." But every one now knows what is meant by the word frame as used in its secondary sense, in connection with pictures, and it is of happy augury in this connection that its ultimate meaning, in its Anglo-Saxon form of *fram*, is "excellent," "surpassing." In fact, frame is allied to the Latin *primus*, "first," and the Sanskrit *paramа*, "most excellent."

had never once given a thought to the historical genesis of the picture frame, until his attention had been drawn to the subject by the spontaneous and felicitous statement of his views and opinions on the artistic question of picture frames with which Mr. Hunter Donaldson had favoured and delighted them that evening. Of course the ultimate origin of picture frames is in the instinct—one of beauty as well as of utility—natural to finite reason, to define, that is, to fix bounds to, to frame-in, everything, even the infinite. Thus according to the Hecatæan geography, which is the geography of Homer and Hesiod, the whole habitable earth, the sun-rise lands [Asia, with Libya], and the sun-set lands [Europa: *cf.* Erebus, Hesperus, Hesperides], is framed-in by the circumfluent stream of outer Ocean; and in the Ptolemaic astronomy, which is the astronomy of all poetry and romance, the Seven Heavens of our planetary system are bound in by the Twelve circumambient Wardens of the Zodiac. Even the infinite comprehension and charity of the "Fides Catholica" has, from the 6th or 7th centuries of Human Salvation, been picturesquely defined by the peremptory terms of the circumscriptive creed of, as is said, "the holy prelate Athanasius." In the Græco-Roman wall-painting of the 1st century A.D., formerly to be seen in the Casa d'Adonide at Pompeii, a pigmy is represented before an easel, painting a picture, and it is clear that he is painting in the frame as he paints the picture. This is what was done in the case of many of the wall-paintings of Pompeii; and what was, and is, done with many of the paintings in the Coptic churches of Egypt; and it is universally done by the native artists of India. The oldest actual example,* of an approximately determinable date, of this simple manner of framing in a picture, known to me, is the archaic Corinthian terra-cotta plaque in the Louvre, representing, in black figure painting, a potter at his wheel, before a heap of clay, turning the wheel with is left hand, and moulding a lump of the clay into a vase with his right, two finished vases hanging above him; the whole framed in with a heavy border of black. This is the proper framing for trivial pictures. In the Græco-Roman painting of the 1st century A.D., from the Casa del Ceruscio, Pompeii, now in the Naples museum, representing a female artist painting a Herm, a Cupid stands before her holding up a sketch of the statuette, stretched on a frame, which is obviously the original of the bald and arid so-called "Oxford frame." This is the identical "pictura in linteo,"—"painting on canvas"—illustrated in Rich's *Dictionary of Roman and Greek Antiquities*, and Dr. Murray would appear to have shown Mr. Hunter Donaldson, in the British Museum, an actual frame of this description. It was evidently derived from the embroiding frame, and the weaving frame, of the ancient Egyptians, Greeks, and Romans; for, at least among the Greeks, pictures were painted with the embroiders' needle long before they were painted with liquid colour and the brush. The only painted picture known to Homer is the "pictura textilis"—"acu picta." The frame of the classical lyre suggests an elegant modification of this otherwise wholly mechanical, unimaginative, and frigid form of frame. The earliest decorative frame known to me is Egyptian of the 14th century B.C., and it at once expresses in the most emphatic terms of art the subtle, sympathetic relations that must always subsist between a frame and the contents for which it is especially designed. In this case the frame and its contents are a specimen of massive jewelry, slightly more than 5 inches broad at the base, slightly less than 5 inches broad at the top, and just 4¼ inches high. It is the sepulchral pectoral, now in the Boulak Museum, of Kha-em-nas, son of Rameses II., and it is wrought in lapis-lazuli and gold. What at once gives this splendid jewel its imposing dignity is that its frame is fashioned in the form of the *naos*, cella, or "holy of holies" of an Egyptian temple; or, as he would himself rather suggest, of the shrine within the "holy of holies." We have another suggestion, of an analogous character, for artistic frames, in the terra-cotta amulets of the 1st or 2nd century B.C., stamped with figures of the Ephesian Artemis and the mystic inscriptions known as "Ephesia grammata." One of these was found at Syracuse, and is to be seen in the museum there. The frame in this case is modelled after the actual ædicula (literally "little edifice"), canopy, tabernacle, shrine, or, in secular language, cabinet, of the goddess in the cella of the temple of the "Great Goddess of the Ephesians;" as that was modelled after the Greek frontispiece of the temple itself, with its pediment crowned with palmetted antifixes, and supported by pillars. In the sepulchral portrait of an Archigallus, or high priest, of Cybele, of the 3rd or 4th century B.C., now in the Capitoline Museum, at Rome, the frame is a plain moulding; from the high priest's neck hangs an amulet of the ædicula type already described; and the sculpture is further interesting from the sort of shallow niche in which the head and shoulders of the figure are countersunk taking the form of the Buddhistic niche, which, in my belief, first suggested to the Greek artists, enslaved by the Arabian conquerors of Syria, the characteristic Saracenic arch. In the small portable shrines of Cybele, of the 3rd and 4th centuries B.C., found in hundreds throughout Asia Minor, and frequently in Greece, we have examples of admirable frames for memorial sculptures; the treatment of the plinth in these shrines especially satisfying the feeling for a strong support for the contained bust or statuette. The ædicula dedicated to Terra Mater, found in the

* On the ceilings of the temple of Amen-Ra, at Thebes, dating from the 14th century B.C., we repeatedly find representations of the vulture, the symbol of Maut, the consort of Amen, floating, on wide extended wings, in a clear, blue sky, bounded on either side, and on top, by a border of darker blue, studded with stars. But this three-sided border is probably a severely conventionalised form of Nuit, the goddess of the over-stretching Midnight Sky, and was evidently in no way intended as a true painted-in frame for these lacunarial tableaux, although it affords a beautiful suggestion of one.

Campo Verano, near Rome, and now in the Palazzo dei Conservatori, at Rome, is, in the artistic force of its severely simple construction, the noblest example extant of this type of sacro-sanct statuary. The representation of the ædicula of the Tauric Artemis on a wall-painting at Herculaneum, shows it to have been an arched canopy of the simplest open construction, resembling a garden wire-work arch, surmounted by a sort of archaic "fleur-de-lis," or semi-"thunder bolt." It would seem to have suggested the decoration of Lord Beaconsfield's statue on last Primrose Day, when the graceful canopy of arched palm branches was somewhat unhappily surmounted by a feebly-modelled coronet of primroses. In short, the ædicula in its endless permutations affords fruitful inspirations, not only for picture frames, but also for statue frames, whether tabernacular or mural shrines, or more familiar niches. So also does the cippus, or tombstone [*cf.* the Greek *stele*, both going back to the phallic pillar, of which the most interesting Roman example was the urban Lar, the Deus Rediculus, also called Tutanus, who had his temple near the Porta Capena] of the Imperial Roman period; as may be judged from the cippi of the 1st century A.D., of Marius, Petilius, and Pintæus, found at Bonn, and now in the Bonn Museum. In the case of the cippus of Marius, in the corners left between the arch of the niche in which the deceased is represented on horseback, and the square head of the stone, are sculptured representations of the "dona militaria" (torques, &c.) conferred on him in life. This is a most happy way of relegating the honorific insignia of great men, which happen to be artistically unassimilable in their portraits, to the decoration of the picture frames. The cippus, of the 1st century A.D., of another eques, found in Rhenish Hesse, now in the museum of Mayence, and that of Q. Sertorius, found at Verona, and now in the Museo Lapidario there, and of Q. Statius, found at Athens, and now in the museum there, are examples of the simple and effective setting of memorial sculptures. On a cippus in the museum at Avignon only the insignia of office—the fasces and the curule chair—of the municipal magistrate commemorated are sculptured below his name. In a Romano-Gallic cippus in the Caen Museum, the tradesman commemorated is represented with a steelyard in his right hand, and the goods he is about to weigh in his left. In the Romano-Gallic cippus in the Sens Museum a blacksmith is represented standing in a niche (modelled from the arched doorway of a Christian church), beside his anvil, with a hammer in his right hand, and his fire-tongs hanging to the left of him. Another Romano-Gallic cippus of the Christian period presents the bust of an innkeeper, in a niche (similarly arched to the last), pouring wine from a flagon in his left hand into a tumbler in his right. There are many such Romano-Gallic cippi, and all are invaluable, not only as graphic illustrations of the arts, and crafts, and trades, of the period, but, more especially in the present connection, of the principles which should determine the artistic treatment, of which the enframing is an integral part, of such subjects. There is a variety of the mural cippus, or it might equally well be said ædicula, called, I do not altogether understand why, armarium. This term is found first applied to a chest for arms, tools, tackle, &c., then to cases for books, cabinets, and cupboards of any kind, and to any room or place for holding tools, books, &c., and, finally, to the shrine-like cippi, or ædiculæ, containing family portraits, reproduced in wood, stone, or metal from the "imagines Majorum," or painted wax masks taken of the Roman nobility immediately after death. The practice of taking these post-mortem masks appears to have been almost universal in antiquity. It was followed by the Egyptians, Assyrians, Phœnicians, Carthagenians, and Italians, and it accounts for the lifelike character of their sepulchral portraiture, and particularly for the vivid individuality of the busts and portrait statues of the distinguished Romans which have come down to our time. There is in the Lateran a so-called armarium, of the Imperial Roman period, of a female member of the family of the Haterii. It was found with other funerary sculptures, all mural, of the family, on the Via Labicana, not far from Centocelle. The equipment,* [whence possibly the designation "armarium,") or framing of the bust, presents a simple pediment, supported by a pilaster on either side, and by a rounded pillar a little in front of the pilaster to the right of the bust The pillar on the opposite side is absent, and appears to have been broken away. On either side, at different levels, there is a bracket between the pilaster and the pillar, intended for a lamp to be lighted in honour of the revered dead. The pediment, within its architectural mouldings, is trailed with flowers on either side of the representation, apparently of a lighted lamp. The pilasters are scrolled with hearts-ease, while the remaining pillar is delicately imbricated. The bust rests on a narrow broken ledge of marble, and this "armarium" evidently wants its proper plinth: yet, as it stands, in the appropriateness, and the religious

* I use "equipment," to avoid the use of "frame," here usable only in the sense of the whole shape, form and structure—including the bust, or other sculptured subject—of this armarial type of mural monument. Armarium, among other things, means specifically a marine store; "armare" meaning [Charta Alfonsi reg: Aragon: 1288] to fit out, equip, a privateer; and in the case cited in the text the armarium is the complementary part, which, with the bust, fully equips, and gives form and shape to the memorial. [Equip, shape, and ship are the same word, and "ship-shape" a tautology.] Armarium is used also by Tertullian for the completed canon of the Hebrew Scriptures. We have, on the other hand, armariolum, for the tabernacle in which the Corpus Christi was carefully kept under lock and key [Statua Ecclesiæ Leodiensis, 1287], and in Low Latin, armariolus, for the little chest in which certain of the utensils useb in the Offices of the Christian Church were kept beside the High Altar: in these two instances armarium corresponding witn the pagan Sacrarium, in which the salinum paternum, patella, an other sacred and mystic ancestral and progenitory symbols, were kept by the Romans.

sentiment, of its elegant and charming design, it is a perfect example of what the enshrining frame of a family portrait should be. The provision of the brackets for lamps at once fascinates the beholder, recalling the daily ceremonial commemorated in the hymn of Prudentius, "Ad incensum Lucernæ;" a beautiful and solemnising domestic rite which ought never to have been allowed to pass into disuse. But it is probably to the "consular diptychs," of the 4th and 5th centuries A.D., that we must look as the immediate precursors of the modern picture frame. The diptych and the triptych—"pictura in tabula"—had probably always existed; and Rich illustrates a triptych from a Pompeian mural painting, the exact location of which he does not give, as suspended, with a considerable forward slant, over a doorway. Under the Lower Empire, the custom prevailed of the consuls and other magistrates, on entering office, presenting their friends and patrons, as also the Christian bishops to whom they wished to be civil, with folding tablets of ivory, or wood, having their names, and their portraits, and their insignia of honour carved thereon. These were in fact their *cartes de visite*, and he (Sir George Birdwood) would fain see the fashion of them revived to the exclusion of the egregious photographic *cartes*. The edges of these consular diptychs are nearly always framed round, in low relief, with conventional decorations, identical in design with those of the frames of gilded "gesso," or of gilded and stamped paper, applied along the edges of the painted diptychs and triptychs, and other wood panel *ikons*, found at the present day among the Greeks, and Russians, and Copts, and Abyssinians. Labarte, in his *Handbook of the Arts of the Middle Ages*, in the chapter on "Painting and Caligraphy," at one time inseparable arts, gives three illustrations, which seem to me very suggestive of the gradual transformation of the panel *ikon*, and diptych and triptych, edging, or "selvage,"—if the word may be so used—into the modern picture frame. The originals of the illustrations are all in the National (formerly Imperial) Library, at Paris. The first, from a miniature of the 15th century, representing a female statue painter, has behind the statuette of the Virgin and Child a panel *ikon* of the Saviour's head, with a heavy, stamped, and obviously gilded, "selvage." The second, from a MS. also of the 15th century, representing a caligrapher at work, has at his feet a panel painting of the Crucifixion, the "selvage" of which is considerably raised above the surface of the paper. The inner edge of the "selvage" is obviously "bevelled" to the surface of the painting. The third, from another MS. of the 15th century, represents a female artist at an easel, painting a picture of the Virgin and Child already fixed in a round moulded frame, with, apparently, the ring for hanging the frame fastened to its top. The parallelism as regards "motives" and the details illustrating them, between the above 15th century miniature, and the Pompeiian fresco of another female artist painting a Hermes, described by the speaker at the commencement of his remarks, was remarkable and profoundly interesting. "Plus ça change plus c'est la même chose." Even more remarkable is the proof of the continuity of artistic methods and appliances, afforded by a painting in a 5th century MS. of the Materia Medica of Dioscorides at Vienna, representing an artist copying a mandrake plant, held up before him by the goddess Euresis, on a quarto sheet of vellum, fastened to the drawing board resting on the easel by six "drawing-pins." The speaker said he thought that in these few references, which might be indefinitely extended, he had sufficiently traced the true pedigree of all the traditionary modern varieties of picture frames, and pointed out the direction in which to look for promptings for their improvement. The Italians of the Renaissance modelled their best picture frames from these ancient armaria, cippi, and ædiculæ, as is very clear from the actual examples, and the reproductions, of Italian renaissance frames in the South Kensington Museum; and it is equally clear that Sir Frederick Leighton and Sir Philip Burne-Jones were directly inspired by the later in designing their classical frames, which, in Sir Frederick Leighton's hands, always harmonise perfectly, with the pictures they contain. If he might generalise from the instances cited, he strongly advised the revival of the use of wood, or metal, or composition, self-edged panels for trivial paintings; while for family portraits, and great imaginative pictures, he would like to see the fullest development given to the picture frame as a shrine; and of course to the enframing by moulding, niche, canopy, or other equipment, of statuary. But the great point was that the artist should have the first and last word in the framing of his work; it should be part of his covenant alike with the patron and the dealer in frames, who both require to be taught that frames have to be made for pictures, and not pictures for frames—not since sculpture and paintings rose above their restricted status as the handmaids of architecture, and became independent fine arts. The frame and its picture are commutually inseparable, as the wine cup from the red wine in it, and as the setting of a jewel from its priceless gems. In the words of Schiller, Truth is independent of its vehicle, but Beauty is made perfect alone by its environment, literally—"the vessel makes the content":—Bei dem Schönen allein macht das Gefäss den Gehalt. The speaker added that he would not enter into any consideration of the views and opinions expressed by Mr. Hunter Donaldson on the strictly æsthetic problems connected with picture frames. Mr. Hunter Donaldson was thoroughly qualified to address them on the subject, which was so fresh, in spite of being so familiar to them, that he knew of no writings of any kind on it, except the papers by Mr. Phené Spiers, mentioned by Mr. Hunter Donaldson, and some papers they had just heard of as having been written 18 years ago by their esteemed colleague on the Applied Arts Committee, Mr.

Hugh Stannus. Mr. Hunter Donaldson was for 25 years a partner in the firm of Gillows and Co., and for nearly 50 years he had been connected with the great international exhibitions held in this country and on the continent. He was, on the nomination of H.R.H. the Prince of Wales, appointed a Juror on Decoration for the Paris Exhibition of 1878, when he was made a "Chevalier" of the Legion of Honour. He was a member of the Lord Mayor's Committee for the Paris Exhibition of 1889, and decorated the British Section; and was promoted for these services to the rank of "Officier" of the Legion of Honour. He was also a Commissioner for the Melbourne Exhibition of 1888, and is a member of the Advisory Committee on Decoration of the British Royal Commission for the Paris Exhibition of 1900. He (the speaker) was under the deepest obligations to Mr. Hunter Donaldson, who was one of a group of very old and very valued personal friends, including the late Mr. Robert Phillips, the late Mr. Foster Graham, Mr. Vincent Robinson, Mr. George Lock, Mr. Lazenby Liberty, the late Mr. Juliano, the late Sir Henry Doulton, Sir Thomas Wardle, and others, to whom he owed all the little practical knowledge he possessed of the artistic industries of this country; and it gave him unfeigned pleasure to propose the vote of thanks to Mr. Hunter Donaldson, which he would ask the Chairman to put to the meeting at the close of their proceeding that evening.

Mr. Hugh Stannus said such a paper as the one to which they had just listened, which gathered into a focus all that had been said or thought upon the subject, was one deserving of their best consideration, and as it was impossible at that late hour to properly discuss it, he could wish that another opportunity could be found for the full discussion it deserved. He had himself given a lecture upon this very subject eighteen years ago, and on looking over his notes he was struck with the similarity of idea in the two papers.

The Chairman said nothing had exercised the minds of artists more than the question of having appropriate frames for their pictures. The difficulty was not only that the style of the frame should be fitted to the picture, but that the particular details of the frame should be absolutely in accord with the picture. In the present day artists could not afford to go to a specialist on frames, they had to trust to the trade carver and gilder. He quite agreed with Mr. Stannus that the subject was one which might be discussed on a future occasion, or form the subject of another paper next session. In conclusion, he proposed a hearty vote of thanks to the reader of the paper.

The vote of thanks was carried unanimously, and the meeting adjourned.

Mr. Philip H. Newman writes:—While the almost unique character of the paper makes it of great academical importance, it is to be regretted that its practical utility is lessened by the nature and conditions of things. Circumstances are inimical at the present time to the application, excepting in a limited degree, of many of those principles Mr. Donaldson and most of us recognise as lying at the root of the subject. On the one hand we are ruled and fettered by the picture exhibitions, which necessitate some approach to uniformity in framing, while on the other we are vexed by modern decorative schemes that almost exclude pictures as incongruous features, difficult at all events to harmonise with such schemes. Putting aside, however, these perhaps temporary difficulties, we have one constantly with us, *i.e.*, the preference almost universally shown for gold frames, although gold in many instances, and of any tone may be the worst possible surrounding for the work it is made to enclose. If we look into the pictures of de Hooghe, Metsu, or Terborch, we find quite impartially black or gold frames hanging on the walls of the painted interiors these artists present to us, and believing, as one must, to a considerable extent in the realism of their art it is fair to suppose that these painters pictured pretty generally what they saw; indeed, the cursory observer might suppose that the Dutchmen knew very little about the matter and cared less, so long as they decently furnished their walls, but on reflection one would incline, I think, to the opinion that the use of black as well as gold frames indicated an experience, if not instincts or scientific knowledge, that the effect of the low tones and deep rich shadows of their pictures was subserved and enhanced to a greater degree by a black frame than by a gilt one. It is for this reason that I attach more value than Mr. Donaldson apparently does to the tonality of a frame rather than to its conformation, although I quite agree with Sir George Birdwood that the pilaster or, as we might define it, portal type, is in its very nature the most suitable form in the majority of instances, and I would add especially so in figure subjects other than rustic or humble genre. All that Mr. Donaldson says in regard to disturbing elements of form is undoubtedly true, but I think it must be admitted that want of suitable tonality may be more disturbing still. In reference to the use of gilding, it has been the custom to regard it for some insufficiently explained reason as a non-disturbing element in decorative work, and axiomatically that gold will take care of itself; that this is not the case, however, is sufficiently obvious by a few experiments with picture frames; it will be found that the interplay of reflections, unless the gilding be toned to nullity always causes disturbance, and halation destructive of the colour values of a painting and their proper appreciation by the spectator. This is made distressingly manifest if one puts an old master into a new frame, but it is equally true of course, in degree, where a new work is concerned. Gilding has always a tendency to

enlarge, and amplify surface, and it is to ignorance of this effect that must be attributed in no little measure some notable failures and disastrous results in recent decorations. A building or room cut up by gold lines or mouldings is sensibly belittled, the mouldings being magnified out of all architectural proportion; on the other hand, gold used in masses, as in the lunettes of St. Mark's, at Venice—to take a single instance—adds apparent size and amplitude to the building. Our aim being to adorn and set off the picture with the frame and not to distinguish the frame by the picture, it behoves us then to be very careful of the tonality of our gold, if gold must be used, or else instead of enhancing the painting we shall, as is so often done, detract from it, by seriously affecting its values. In regard to the difference of framing in oil or water colour works, the latter have for many years so nearly approached the former in force and richness as to necessitate very little variation of treatment in framing. There are, of course, cases where the scheme of colour is very light as in landscape sketches, having skies with large areas of light clouds, &c.; in these instances white or light mounting gives an additional charm in the nature of a vignette. In reference to the framing of photographs, the most satisfactory results are obtained when the tones of the photograph are borne out by the prevailing colours of mount and frame: a dull green frame is possible with some cool grey photographs, especially when there is relief by dull gold. I regret that I cannot agree with the reader of the paper in several instances in his general admiration of the mounting of the photographs which were shown on the walls.

General Notes.

Coal in Kent.—At the opening of the Fourth Annual Congress of the South-Eastern Union of Scientific Societies at Rochester, on the 26th May, Mr. W. Whitaker, F.R S., President of the Geological Society, and President of the Union for the ensuing year, delivered his inaugural address, the subject of which was, "The Deep-Seated Geology of the Rochester District." Alluding to the borings that had been made for coal in Kent he suggested that that neighbourhood was one in which trials should be made. To get coal they had to go something like 2,000 ft. down, and they could be sure that the people who wanted the coal would not dig more holes than they could help. He felt that the discovery of a new coalfield was a very important thing. The prosperity and wealth of the nation depended very largely upon coal. Therefore, if it affected the pretty scenery around they must bear with that for the general good. He did not see why the effect on the scenery should be so excessive as people generally thought. Coal, like chalk, might be worked all out, and when a colliery was exhausted the country would revert to its natural state. Of course, it was uncertain where those coal-fields were, and they could only make a guess at it. The only thing was to try and prove whether they existed there. That would be done some day, whether people liked it or not, because if there were valuable riches underground, they would be forced to look after them.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 5...Farmers' Club, Salisbury-square Hotel Fleet-street, E.C., 4 p.m.
Royal Institution, Albemarle-street, W., 5 p.m. Centenary Day Celebration.
Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. R. G. Allanson-Winn, "Foreshore Protection, with special reference to the Case System of Groyning."
Chemical Industry (London Section), Burlington, house, W., 8 p.m. 1. Dr. S. B. Schryver, "A New Method for the Analysis of Commercial Phenols." 2. Dr. S. Rideal, "A Demonstration of Printing by Electricity without the Aid of Rollers or Ink." 3. Dr. J. Lewkowitsch, "Notes on Cacao Butter."
Geographical, University of London, Burlington-gardens, W., 3 p.m. Annual Meeting.
Actuaries, Staples-inn Hall, Holborn, 5 p.m. Annual Meeting.

Tuesday, June 6...Royal Institution, Albemarle-street, W. 3 p.m., Centenary Celebration. Commemoration Lecture by Professor Lord Rayleigh. H.R.H. The Prince of Wales, K.G., Vice-Patron, presiding. Evening Reception by the Lord Mayor to Members, Foreign Guests and Representative Men, at the Mansion-house.
Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.
Zoological, 3, Hanover-square, W., 8½ p.m.

Wednesday, June 7...Royal Institution, Albemarle-street, W., 9 p.m., Centenary Celebration. Commemoration Lecture by Professor Dewar, F.R.S. His Grace the Duke of Northumberland, K.G., President, presiding.
Geological, Burlington-house, W., 8 p.m.
Civil Engineers, 25, Great George-street, S.W., 10¼ a.m. Engineering Conference. Opening Address by Mr. W. H. Preece (President).
United Service Institution, Whitehall, S.W., 3½ p.m. Lieut.-Col. R. L. A. Pennington, "The Training of a Battalion of Infantry."
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 20, Hanover-square, W., 8 p.m.

Thursday, June 8...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 10¼ a.m. Engineering Conference (continued).
Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, June 9...Civil Engineers, 25, Great George-street, S.W., 10¼ a.m. Engineering Conference (continued).
Astronomical, Burlington-house, W., 8 p.m.
Physical, Chemical Society's Rooms, Burlington-house, 5 p.m.

Saturday, June 10...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, JUNE 9, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1900.

The Society's examinations for the year 1900 will be held on March 26, 27, 28, and 29. The last day for receiving applications will be the 7th of March. This early intimation is given for the convenience of the Managers of Institutions who are preparing their own programmes for next year. The Society's Examination Programme will be issued about the usual date—the end of August.

CONVERSAZIONE.

The Society's *Conversazione* will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, 20th June. The reception by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman, and other members of the Council, will commence at 9 p.m.

The following portions of the Museum will be open:—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery; on the First Floor—the East and West Corridors.

A selection of music will be performed by the String Band of the Royal Artillery in the Central Hall, and by the Red Hungarian Band in the Bird Gallery, commencing at 9 o'clock.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. These tickets have now been issued. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the *Conversazione*. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary) or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

The entrance to the Museum is in the Cromwell-road. Carriages must enter the grounds by the east gate and leave by the west gate. The cards must be given up on entering the Museum.

Visitors arriving or leaving by either of the Metropolitan Railways will be allowed the use of the District Company's Subway, which leads from the South Kensington Railway Station direct into the grounds of the Museum.

Fuller particulars as to the musical and other arrangements will be given in the Programmes which will be distributed on the evening.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 30, 1899; Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., in the chair.

The CHAIRMAN said Mr. Starkie Gardner needed no formal introduction to a meeting of the Society of Arts. He was known to everyone familiar with the history of the remarkable revival, in the current generation, of the artistic industries of the United Kingdom, his name being indentified with the resuscitation, during the past fifteen or twenty years, of the once famous English art of decorative iron work, both founded [*i.e.*, "poured" out] or cast, and forged [*i.e.*, "fabrica-ted,"—fabre-fact-ed] or hammered [*i.e.*, "smilt(h)en"]. We would appear to have had a reputation for the artistic treatment of iron, even before the spacious times of our great Tudor sovereigns, Shakespeare, with perfect historical propriety, making, in III. Henry VI., II., 2, the Duke of York taunt Queen Margaret with being:—

"Iron of Naples, hid with English gold."

To the Society of Arts, in particular, Mr. Starkie Gardner was intimately known, both as an active member of our Applied Art Section, and as a most highly esteemed lecturer. The first paper he read before us was in 1887, on "Wrought Iron Work." It was subsequently expanded into the South Kensington Museum *Handbook on Ironwork*, of which (owing to

one of these preposterous mysteries of clerical procedure that are never to be understood by the laity), it is to be deeply regretted, only the first two parts have as yet been published. Mr. Starkie Gardner's second paper here was in 1888, on "Monumental Brasses;" his third, in 1891, on "Enamels and Enamelling;" and his fourth, in 1894, on "Pewter." They are all papers of unusual interest and merit, and with the paper to be read that evening, they cover nearly the whole ground of Mr. Starkie Gardner's enlarged practical experience as a thoroughly trained and highly accomplished art worker in every department of decorative casting and smithing. In enriching our *Journal* with these five papers, Mr. Starkie Gardner has rendered an invaluable service to the Society of Arts, and laid us under lasting obligations to him, and he may be assured of our unfeigned gratitude, mixed though our gratitude might be, as for his own part he confessed it was, with something of the sense of yet further favours at his ever helpful hands. He hesitated to express his own admiration of Mr. Starkie Gardner's special work as a craftsman, for to do so might be taken to imply that he had some title to speak, among the experts present, on the subject—and he had none. Nevertheless, and as he was old enough to be Mr. Starkie Gardner's father, he would venture to indulge himself, and say frankly, that in all the range of contemporary decorative art, there was nothing more delightful to him than the characteristic productions of Mr. Starkie Gardner's melting-pots and stithies in Lambeth. From the beginning Mr. Starkie Gardner had led the revival, during the past fifteen years, of artistic smithing in lead, pewter, copper, bronze, and iron; the rapidly spreading popular appreciation of artistic iron work in particular is wholly due to his personal labours and influence; and he is now everywhere recognised as standing at the very head of the old English art he has recreated among us, and restored to its former place of pride and honour in this country. After basket making, weaving, and potting, smithing—earliest in copper, later in bronze, and, last of all, in iron—was the most ancient of arts, and it remains the master craft of all crafts, without which few of them would ever have reached their present excellency. The use of iron, in place of wooden, stone, copper, and bronze tools, was indeed a great factor in at once differentiating Greek from Egyptian sculpture, the latter continuing to be wrought with the traditional tools even after the introduction of iron into Egypt. The terms "faber" and "fabrica" were first applied among the Romans to the blacksmith and his workshop respectively, and "faber" continued to mean, *par excellence*, blacksmith, even after the application of the term was extended to any artisan, and "fabrica" to any workshop, and the blacksmith was specifically designated "faber ferrarius." In all his fabrefactions there was the strong impress of his own individuality; the individuality not only of the born and laboriously trained artificer, but of one who had received into his heart the elevating and refining inspirations of scientific and literary culture. Before Mr. Starkie Gardner became a worker in iron—"faber ferrarius"—he had devoted himself to the study of natural history, more especially of botany, conchology, and geology; and he has contributed several papers to the transactions of the Royal Geological Society, and published a book on the fossil coniferæ. It is obvious to anyone who has seen typical examples of his iron work, that these studies have been of the utmost use to him, not only in draughting his designs, but in actually manipulating the details of them at the forge. But these studies have been of still greater advantage in fostering in him, above a thorough knowledge of his trade, the love of his art. It is true that a handicraft is made perfect only in the loving observance of its art—"servus arte fabrica peritus;" but in all the work that Mr. Starkie Gardner has produced during the past fifteen years, he has produced nothing that is not becoming to, and to the greater credit of, his art, and he has produced nothing for the sake of trade only. This is the highest praise that can be accorded to an industrial artist, and by general consent, it is the praise pre-eminently due to Mr. Starkie Gardner. He has lived for this praise; and as epigrammatically formulated—with another application—in the well-known, but never hackneyed, line from Seneca, it might well be inscribed over the entrance to his fabrica in Lambeth:—

"Id facere laus est quod decet, non quod licet."

The paper read was—

THE REVIVAL OF TRADESMEN'S SIGNS.

By J. Starkie Gardner.

When, at the request of our Chairman, I undertook to read a paper on "Signs," I hoped that not much research would be necessary. I soon, however, became aware that to do justice to it would be almost like writing a history of England. I only now begin to understand why our Chairman selected it, and that I was perhaps somewhat rash in agreeing to undertake the preparation of such a paper. But that books on the subject have already been written by Larwood and Hotten, Philip Norman, and Hilton Price, I could hardly have dealt with signs at all this evening. To become really a pundit on this difficult and abstruse subject, some knowledge of heraldry, astrology, mythology, theology, archæology, zoology, history, biography, and geography, is needed. I scarcely possess more than a limited acquaintance with many of these branches of knowledge.

The necessity for displaying some sort of sign, if one wishes to barter goods, accom-

modation, or service, against money or kind, can hardly be disputed. In a new settlement the first care of the intending storekeeper is to scrawl his name and trade on a piece of wood and hang it out to attract the passers-by. In America this is called "setting up one's shingle." The necessities of the budding communities of to-day were no less felt in the past. In days when customers could not read, a representation of the commodity on sale would be more serviceable than an inscription. If opposition stores were competing, more telling representations of the same objects, more attractively rendered, would serve to distinguish one establishment from the other.

Such signs must have been in use from remote times. It is only when the wares themselves can be displayed to the passers-by in safety that signs can be dispensed with, as in open bazaars and markets. In the East, time-honoured customs of trade and hospitality rendered signs unnecessary, and there is no mention of them in the Bible, Josephus, or the Arabian Nights. Neither has anything indicating their use been met with in the excavated cities of Asia and Africa. It seems, in fact, that signs were an institution almost peculiar to Europe, for it is only within its limits that records of them appear — doubtfully in ancient Greece, but with certainty in Rome. The most venerable is that of the Bush, denoting the tavern in Italy, which reached Roman Britain. Our ancient proverb, "Good wine needs no bush," commemorates this most venerable of signs, the symbol of the house in which jovial companions foregathered. The Cock, and the Chequers, are also Roman signs, which, no doubt, equally found their way here, and link our civilisation with that mighty Empire,

FIG. 1.—DESIGN BY TIJOU, 1693.

our indebtedness to which we are perhaps apt to underrate.

In the earliest times, when people in England were mostly illiterate, only very easily understood signs could be used, clearly denoting the nature of the establishment and the trades carried on. In days when people and things actually were what they seemed to be, and there were no shams, embattled walls really symbolised the power of the noble, and banner-shaped vanes and finials proclaimed his degree. The church, the monastery, the mill, the smithy, the shambles, the malt-house, were all easily recognised; the tavern or ale-house almost alone required some distinguishing sign. We consequently find that the earliest ordinances made it compulsory for these to display the Bush—the ivy bush—sacred to Bacchus; whilst other traders might display signs or not as they pleased. In the towns where more recondite trades were carried on, their kind was advertised by such articles as a wool-pack, tailors' shears, barbers'-pole, oil-jar, or magnified boot or glove.

All signs of this nature are common or collective—that is, used in common by all engaged in the same trade. They are scarcely mentioned by old writers, but are seen in the earliest illustrations, something very like a "wine bush" appearing in the Bayeux tapestry. Among well-known examples of collective signs are the three golden balls of the goldsmiths, the three gold crowns of the drapers, the vintners' three tuns or bunch of grapes, the wheatsheaf of the brewers and bakers, the compasses of the masons and carpenters, and so on. Interesting as this branch of the subject might prove, it is not my intention to pursue it farther to-night.

Signs, distinguishing and peculiar to individual establishments, are the product of a later and more sophisticated stage of civilisation. They, perhaps, only came into use on the definite adoption of distinguishing badges by the nobility. The noble in residence in a city would, in feudal days, entertain his vassals and neighbours coming from his own part of the country; and, in his absence, hospitality would be dispensed by his seneschal or major-domo. Doubtless, as the feudal feeling relaxed, and guests became more casual and numerous, some payment might be looked for, if not by the nobleman, by his stewards. Similarly, in hospices and monasteries, entertainment could be had, but payment from the well-to-do would be expected, as it is in continental hospices at the present day. In very remote parts, where travellers are rare, one is warmly welcomed, and no payment accepted; in more frequented routes, however, payment, though nominally optional, is expected; whilst along the regularly beaten tracks bills are made out and presented in the usual way. Under the latter circumstances, the business of entertaining well-to-do travellers becomes a source of considerable profit, and the nobleman's steward, equally with the rich merchant, would fix up some sign indicative of a readiness to receive paying guests. The citizen would distinguish his house by some fanciful device, like the trade marks of to-day; or by a rebus, such as that handed down as the Bolt-in-Tun. We know that the nobleman displayed a painting of his arms on his town house, a custom surviving to this day in the painted hatchment. No less a person than the poet Chaucer, summoned as a witness in the Scrope and Grosvenor dispute, as to the right to the Bend-or, deposed that in walking up Friday-street he saw a sign with these arms painted on, put there by a Knight of Chester whom he had not previously heard of. Amateur Bonifaces were distinguished from professional as "herbergists," and their houses only resorted to by people of substance. Such establishments were, beyond doubt, the origin of the *boná-fide* hostelry or hotel.

Individual signs, unlike the collective signs, are referred to by nearly all our older writers, such as Chaucer, Froissart, Shakespeare, Ben Jonson, Beaumont and Fletcher, and some of them are inwoven into our national history. Some still existing signs vie with, and even surpass, our oldest families in their venerable antiquity, dating back to the Plantagenets. The more ancient, if existing, would present a pictorial history of our manners, customs, sports, and pastimes for 500 years past, and more or less correct representations of all our popular heroes. Walpole, writing a century and a half ago, remarked:—

"I was yesterday out of town, and the very signs as I passed through the villages made me make very quaint reflections on the mortality of fame and popularity. I observed how the Duke of Cumberland's Head had succeeded almost universally to Admiral Vernon's, as his had left but few traces of the Duke of Ormond's. I pondered these things in my head, and said unto myself, 'Surely all glory is but as a sign.'"*

The custom of not merely two, but hosts of a trade agreeing to cluster together, as in Goldsmiths'-row, Leather-lane, Ironmonger-lane,

* Walpole to Conway, April 16th, 1747.

Budge-row, rendered it difficult to find enough appropriate and specifically distinguishing names to provide for each establishment, a difficulty such as is encountered in christening our numerous men-of-war to-day. For such multitudes of distinctive signs the realms of history (natural, sacred, profane and fabulous), of husbandry, travel, humour, of gastronomy and astronomy, the *ménage*, religion, sport, and profanity, were ransacked. Everything npon, above, or beneath the earth was pressed into the service, from the Virgin Mary to His Satanic Majesty; from our sovereign lord the King to Dirty Dick; the Moon and the Cheshire Cheese. The Cockatrice, Phœnix, Salamander, Griffin—fearful wildfowl these—and the more popular of the patron saints, figured largely on the signboard; nor were the ever-welcome devotees of the Leather Bottel and Pewter Tankard unremembered.

Of such signs as the Sun, Star, Crescent, Dolphin, Flying Horse, Fortune, Elephant, Bear, Lion, Cock, Wheatsheaf, Ivy and Vine, and Chequers, it is impossible to guess the antiquity. Some belong to Pagan times. The Adam and Eve, Salutation, Angel, Virgin, Baptist's Head, Crosses and Cross Keys, Mitre, Nuns and Friars, must be Christian—signs like Neptune, Atlas, Hercules, Golden Fleece, smack of more freethinking times; while the Mother Redcap, Mother Shipton, Dick Whittington, Robin Hood, Guy of Warwick, the Black Prince, and the John of Gaunt, Falstaff and Palsgrave, speak for themselves.

Some of the many Kings and Queens Heads and Crowns may date back to mediæval times, The landlord of a Crown Inn was executed by Edward IV. for venturing upon the mild joke that he had made his son heir to the crown. The Tabard and the Bell in Southwark are mentioned by Chaucer in 1383, and the White Hart, hard by, was Jack Cade's headquarters, and has been immortalised by many pens, from that of Shakespeare to Charles Dickens. This, with the Antelope, Dragons, Red, White, and Black Lions, White and Blue Boars, Swan, Hawthorn, Feathers, and Rising Sun, were Plantaganet badges and extremely popular while the dynasty lasted. Henry V. was entertained at a Red Lion on his return from Agincourt in 1415. The White Hart in Bishopsgate bore till quite recently the date 1480 on its front. The Boar's Head in East-cheap is mentioned in the time of Richard II., and was once London's principal tavern. It was in this house that Prince Hal and his two brothers made such a riot that they merited the attention of the mediæval chucker-out and were taken before the magistrate. The Duke of Somerset, prophetically told to beware of castles, was killed by Richard Plantagenet in a Castle tavern. The Chequers on the Hoop was visited by Chaucer's "Canterbury Pilgrims," and a Chequers tavern stood in Lambeth in 1464.

The Tudor badges naturally supplied a fresh set of popular signs, of which the Rose was the favourite. Our saying "Under the rose" has not, however, an English origin. Perhaps some present have sat under the huge rose in the pleasant vaults of Bremen, where the town councillors were wont to meet to quench their thirst with draughts of Rhenish. The Bull and Mouth and Bull and Gate are believed to commemorate an event in the reign of Henry VIII., the taking of Boulogne. Bulls and Bears became extremely popular signs under Elizabeth, when baiting these animals was the favourite national amusement.

There must have been a great massacre of Popish signs upon the demise of Queen Mary, such as Cross Keys, Maidens, and Catherine Wheels. The Three Nuns, in Aldgate, mentioned by Ben Jonson, and the Pope's Head in Cornhill, which existed in 1464, and the Mitre, in Cheape, extant in 1475, are notable survivals, which still continue to flourish. These, like the Three Cranes in the Vintry, and the Mermaid Tavern in Bread-street, were once household words. It was in the latter that Raleigh established a literary club frequented by Shakespeare and the wits of the day. The only known letter to Shakespeare is dated from the Bull Tavern in Carter-lane. Of equal celebrity were the Rainbow and the Devil in Fleet-street, and Hell and Heaven, in Westminster, alluded to in Butler's "Hudibras." The Society of Antiquaries was incubated in the Young Devil Tavern, in Fleet-street, though the august society in whose rooms we are assembled, was evolved in the cooler atmosphere of a coffee-house hard by. Of the religious signs spared on the death of Mary, comparatively few survived the more drastic disestablishment under the Protector, Cromwell. An Act of Parliament even extinguished the Golden Cross, in the Strand, as savouring of superstition.

Of the signs introduced by such events as the Stuart Accession, the Commonwealth, and the Restoration, it would detain you too long to speak. Neither can we run through the catalogue of the hosts of admirals, generals,

litterateurs, and poets commemorated during the centuries of struggle, through which we have attained to our present state of wealth and prosperity. Long may it be ere the Vernons, Drakes, Benbows, Rodneys, Nelsons, Keppels, Granbies, and Marlboroughs disappear from our sign-boards, and the nation ceases to drink to their memories and think of their deeds. The innumerable whimsical, fantastic, or far-fetched signs must also be passed over. The sporting signs of the Horn, the Greyhound, the Gun, the Nag's Head, the Old Fox, the Coach and Horses, Spotted Dog, Horse-shoe, Fox and Hounds, Hare and Hounds, and Dog and Duck are dear to many, and speak of the tastes of our ancestors even more than of our own. When destined to disappear before the march of progress, may

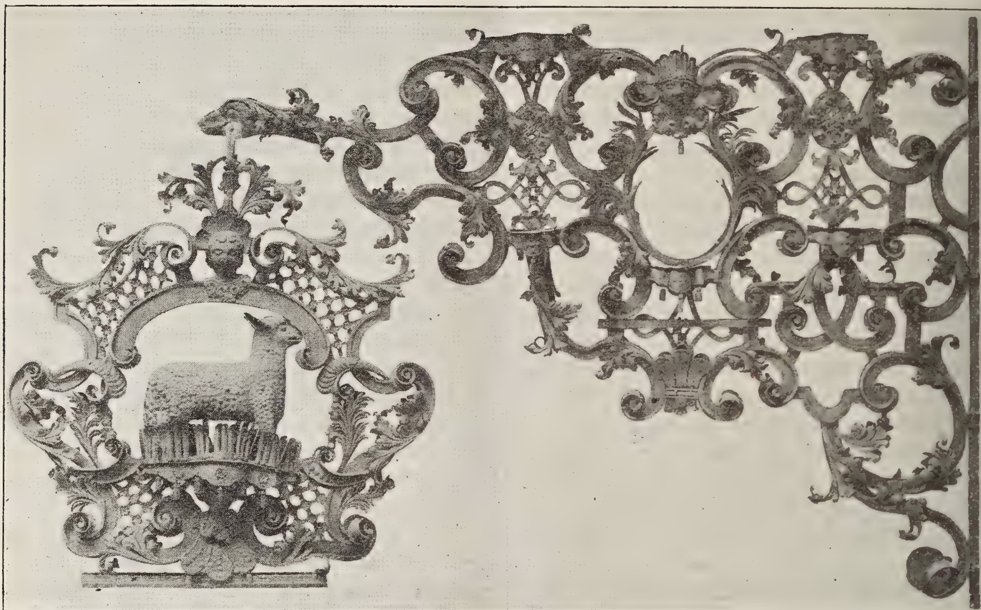


FIG. 2.—SIGN AT WÜRTZBURG, BAVARIA, 18TH CENTURY.

FIG. 3.—BREWER'S SIGN, ANTWERP, 17TH CENTURY.

some at least survive, like those perpetuated in the names of streets and squares, as Half-moon-street, Hart-street, Red Lion-street and square, and Falcon-square.

Under Richard II. it had been made compulsory on inn-keepers to hang out signs. though other trades might do as they pleased, Within 20 years of his death, the great projection of the "ale stakes," as tavern signs were then called, impeded the highway, especially in Cheape, and injured the stability of the houses, and an Act was passed to limit them to not more than seven feet in length. Repressive and permissive measures seem to have alternated ever since. Sometimes the streets were graced with innumerable signs, hung out as banners are on gala days, their numbers defeating the object in view by obscuring each other. The efforts to outvie one's neighbours, caused the signs, at times, to become so serious a nuisance, that legislation had to be resorted to. Charles I. granted to the citizens of London on his accession, as a special boon, the right "to hang out signs and posts for the better finding out of their dwellings, shops, arts, or occupations, without impediments, molestation, or interruption of his heirs or successors." His son, Charles II., however, took advantage of the Great Fire to abolish this privilege, and compelled all signs to be fixed to the face of the house. This fashion of fixing painted signs to house fronts, instead of hanging them out, has been maintained on the death of armigerous occupiers up to the present day. The carved stone and cast-iron signs let into the fronts of houses, chiefly date from the edict of Charles II. Soon afterwards, the hanging signs were again numerous, the difficulty of providing names introducing a dual nomenclature, when such combinations as the Cock and Bull, Cat and Fiddle, Goose and Gridiron, became the fashion. The necessity for signs relaxed when the streets were numbered. This commenced in 1708, it appears, with Prescott-street, Goodman's Fields, for Hatton writes "instead of signs the houses here are distinguished by numbers, as the staircases of the Inns of Court or Chancery." Until then it was absolutely necessary to identify houses unprovided with signs or some distinguishing feature, as in the vicinity of some other house adequately

FIG. 4.—EXISTING SIGN AT BRUGES, 16TH CENTURY.

distinguished by some sign as "over against" the Load of Hay or Yorkshire Grey. Omnibuses, like their forerunners the stage coaches, still as far as possible choose public-house signs to mark their destinations and stopping places. The coffee-houses in the 17th century, entirely new and smart institutions, struck the greatest blow at the use of signs. Wishing it to be understood that they were not to be classed with the older tavern, they broke away from old customs and inaugurated the new mode of merely writing up the name of the owner as Dick's, Tom's, Wills', Sam's, Buttons', Peales', or more high sounding names as the Smyrna or Cyprus. The last repressive Act was passed in 1762, for taking down all overhanging signs under a penalty of £5 and 20s. per day, and this was so effectual that scarcely any remained by 1770, except a few over the book-stalls in Holywell-street, which are noticed by Mr. Wheatley, in his book on London, as existing down to 1849.

The mediæval form of projecting sign, as pictured by Larwood and Hotten in their excellent book, was a carving in wood fixed within a hoop. The hoop was a very venerable and ancient affair, handed down from Pagan times. The ivy garland in honour of Bacchus, the so-called "bush," and the universal tavern emblem, required a backbone, and this backbone remained after the ivy had been stripped from it. Some ancient illustrations show that the tavern "Bush" became elaborated into a series of intersecting hoops, garlanded over, and surmounted by a crown of evergreens, perhaps additionally decorated with ribbons on gala days. From simple and pure to rich and fantastic is the order of progress in matters decorative, with set-backs when revulsion of feeling sets in. The Jacks-in-the-Greens, nearly the last and now almost extinct survival of the old May-day revels, but which were quite common in my younger days, were merely tavern signs perambulating the streets. Jacks-in-the-ale-house, but the ale-house turned loose into the streets, attended by a motley crew of revellers. Sayings such as "As wise as an owl in an ivy bush" show that the words tavern and bush were synonomous. When the mere "bush" no longer sufficed the existing hoops were utilised to hold some badge distinguishing the house, specifically distinguishing badges being held to be *de rigueur*, garlanded and beribboned, it may be, on festival days. A George-in-the-Hoop is recorded as a tavern sign of the reign of Edward III., and others as Cocks or Hens "in-the-Hoop" are mentioned in the time of Henry VI., and to these doubtles the singular phrase "Cock-a-hoop" is to be traced.

Belonging to a much later period is the more sophisticated fashion of hanging out actual pictures illustrative or descriptive of the name of the house. These were set in richly-worked frames, and often depended from very handsomely-carved or worked brackets or supports. There are vague traditions that pictures by such world-renowned masters as Holbein, Correggio, and Paul Potter, have suffered the indignity of having been thus hung out to attract the passer-by. It is absolutely certain that paintings by celebrated English academicians, such as Hogarth, Wilson, Harlow, Moreland, Old Chrome, David Cox, and others, have served this purpose. Some distinguished academicians as Cipriani, Charles Cotton, Samuel Wall, and John Baker, really commenced their careers as sign-painters; and, if we may draw conclusions from the price of £500 paid for a picture of Shakespeare for a sign in Little Russell-street, Drury-lane, the profession was perhaps not a bad stepping-stone to more enduring honours—especially as those called in to paint the sign sometimes stayed to paint the apartment as well. The paintings of a room in the Pope's Head, Cornhill, deserved the encomiums of the genial and observant Pepys; and those of the Rose, near Temple Bar, of the more critical Walpole. The great mart for the average pot-boiler sign kept in stock was Harp-alley, Shoe-lane, while a more *recherché* class could be commissioned from the coach-painter. In 1762 an exhibition was held by a self-styled Society of Sign Painters, to which Hogarth, who fully entered into the joke, was a contributor.

When picture signs were so popular and at times magnificent, the supports and frames which surrounded and suspended them were worthy of them. These were of carved wood or iron, or of both combined, gilded and painted, and sometimes so preposterously massive as to pull out the front of the house they adorned. A particularly ill-contrived construction caused a front to fall out in St. Bride's-lane, in 1718, killing, with others, the King's jeweller and two ladies. A sign of the Three Queen's in Clerkenwell, on the other hand, was so firmly built in, that when ordered to be removed, in 1764, it cost £200 to take down. Among the many large and elaborate

constructions London could boast of, those pre-eminent and reputed to be the largest, were the signs of the Castle in Fleet-street, and of the White Hart in Southwark. A Frenchman, by name Misson, visiting England in 1719, says that though signs were kept small in Paris by restraining influences from above, in London they jutted out so far as to touch each other, and to stretch right across the narrower streets to the opposite wall. Many, he remarks, with their painted and gilt iron supports, must have cost over 100 guineas. Another Frenchman travelling in England in 1765, saw nothing to chronicle on landing at Dover, except the enormous size of the public-house signs, and the ridiculous magnificence of the ornaments with which they were overcharged. Every sign formed a triumphal arch which crossed the streets. A picture of a particularly elaborate sign, that of the White Hart at Scole, in Norfolk, which cost, in 1655, £1,057, represents an immense arch with carved panels of deities and heraldry, crossing from the house and resting on a brick pier on the opposite side of the road.

As a practical worker in iron, it may naturally be expected that I should show more partiality for the iron brackets which supported the signs than for any other part of the structure. This is in truth the case. When and where iron was first used for the purpose I do not know, and therefore shall not pretend to say, but probably the use dates well back into the middle ages. Illustrations of iron sign brackets occur in the design books of the 17th and 18th centuries. That such a renowned architect and designer as Jacques Androuet Du Cerceau should have thought it worth while to devote a page of illustrations in his celebrated treatise on architecture to them, proves that so far back as the 16th century iron sign brackets were esteemed as vehicles for artistic treatment. The designs are in the taste of the day, simple and slightly inclining to the geometric, charmingly evolved by a refined ornamentist, but not by a practical iron worker. The illustrations were published in 1570 (see Fig. 6, p. 620). The author lived in a house with the sign of the hoop, and the surname, Du Cerceau, "of the Hoop," which afterwards became so famous, seems originally to have been a nickname, due to this circumstance. The introduction of the human figure implies that smithing of the highest order was available, and probably that of France in the Renaissance has never been surpassed. Next in point of date is the leaf from the treatise of a practical mechanic—Mathurin Jousse (see Fig. 5), who dates from La Flèche, and wrote in 1625. This is the earliest treatise on smithing extant. The designs are crude and not particularly well drawn. It must be remembered that the French in the second half of the 17th century, far from encouraging extensive signs in their streets, restricted them by law to very modest dimensions. Probably, for this reason, none of the great designers in France, who published such sumptuously-illustrated books on iron work, have cared to give any illustrations of sign-brackets. It was otherwise in England, how-

Fig. 5.—Designs by Mathurin Jousse, 1625.

ever, at this time, as we have seen, for magnificence in the matter of signs was the order of the day. Nothing more elaborate can well be imagined than the three designs for sign-brackets comprised in Tijou's book, published towards the close of the 17th century (see Fig. 1, p. 613). Tijou, it is known to most of you, was the designer and contractor for the iron work at Hampton Court Palace, St. Paul's Cathedral, Chatsworth, and other places. Any smith present will, however, at once perceive that these designs could never have actually been carried out, or even drawn by a practical man. They go far to prove, I may incidentally remark, that Tijou was not himself a crafts-

man or expert, but merely a designer, whose designs, moreover, required a very great deal of alteration at the hands of experts before they could have been handed out for execution by the smith. The old tradition that Huntingdon Shaw, of Nottingham, really executed the work may not be far wrong. His charming book of designs, published in 1693, has been reprinted by Messrs. Batsford. This by the way. Unfortunately, illustrations of English sign-brackets previous to the enactment of 1765, which condemned them to destruction, are extremely rare. Though Hogarth incidentally depicts a great many signs, only one is at all an elaborate piece of iron work.

Of actually existing iron sign brackets, there are none in England, speaking according to my limited knowledge, older than the Chippendale or Adams' periods—few, indeed, being more than a century old. To find older examples we must pass over to the Continent. The most ancient that I have met with is the remarkable bracket in the Marché du Vendredi at Bruges, from which still depends the model of a curry-comb (see Fig. 4, p. 617). Judging from the contemporary font-cranes, which it greatly resembles in its details, it must date from about 1500. There are a few others in the Low countries, preserved in museums, of almost equally early date—all, both sign and bracket, being solely of iron. In Germany a few of late Renaisance date may still exist, like the fine specimen illustrated, and now in the South Rensington Museum ; but as in the Belgian, the vast majority are of the style of Louis XV., known as the Rococo. None appear to have been designed for hanging pictures, but only to include signs made of beaten iron or copper. Those designed to receive a huge representation of a key, the sign of the locksmith in Germany, are the most elaborate, serving to illustrate practically the skill of the craftsman seeking custom as well as to decorate his abode. In France few sign brackets seem to have survived the Revolution, and in Italy and Spain there are practically none. No signs exist in England which can in any way compare with the series of illustrations of those in

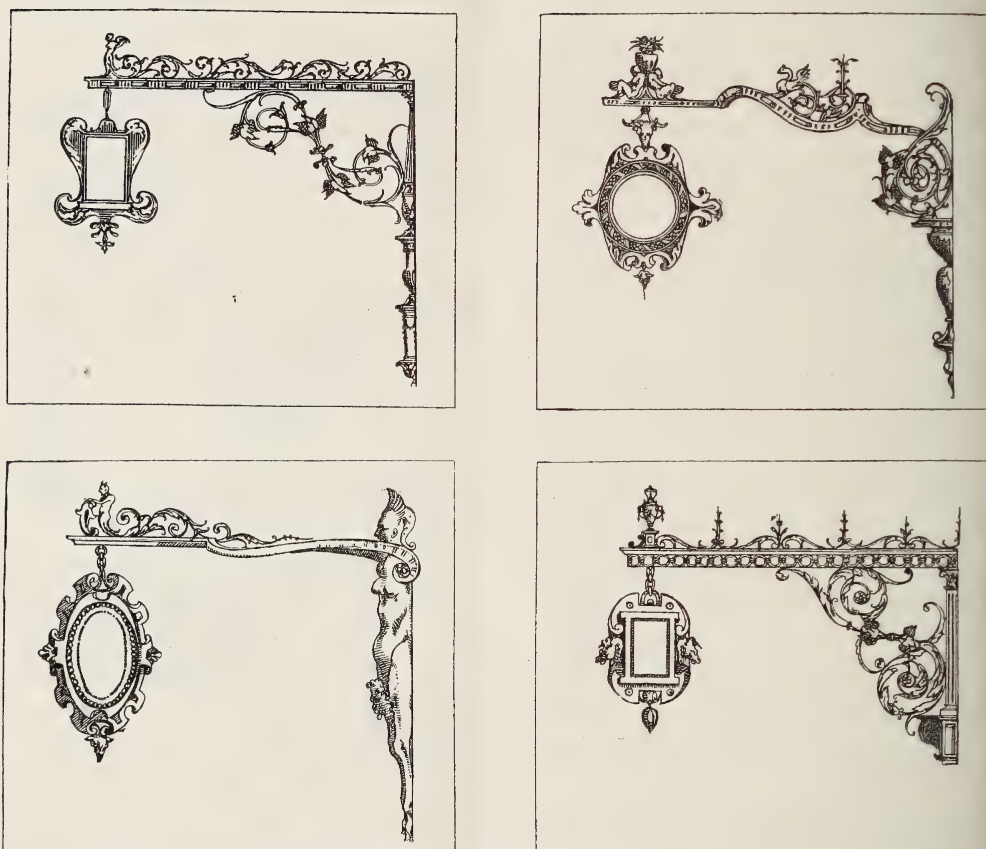


Fig. 6.—Designs by Androuet du Cerceau, 1570.

the Brussels and other museums abroad. We are a law-abiding people, and allowed a clean sweep to be made of all our signs in the last century—scarcely an example remains dating farther back than 1762. With the sweeping law of that date all continuity and traditions of design were broken and never revived. The few that now exist are unlike the older ones, merely rudely embellished stays and supports to hold a board with the name of the house painted on it. They are frankly utilitarian. Now and then we chance upon a more pretentious example, elaborated by some local talent, but they are uniformly of flimsy workmanship and destitute of any principles of design. One of the best examples, is that at Mere, Wilts. There are others at the Bull, Bruton ; the George, Thame ; the Black Swan, Frome. They are all rather timidly executed in the earlier part of the century. Though so simple and late in date, village signs are often found in the travelling artist's sketch - book. They are certainly pleasing adjuncts to the village alehouse, and serve their purpose admirably.

It may be debateable whether hanging signs should be permitted in our London streets or not. If well designed and not too numerous, they add a certain picturesqueness —especially in certain situations. So long as they cause no practical inconvenience or danger to the public it would seem supererogatory to prevent money being spent in the decoration of our not-over-beautiful thoroughfares, and to abrogate a privilege and custom that has, on and off, existed for several centuries. The omnipotent London County Council not having as yet definitely decreed that no more signs shall be erected in London, I am enabled to add a few modern examples to my series of pictures both of other people's and my own productions. The place of honour in this series must, I think, be accorded to the sign at the bottom of St. James-street, designed by Mr. De Wilde, once, I am pleased to think, on my own staff. It hangs high, but is very effective and well proportioned, and not inharmonious with the Norman Shaw building on which it is placed. An additional merit is that it is a pioneer, having been the first important sign put up in London during her present Majesty's reign.

Another very striking sign is to be seen at Heath's, the hatters, in Oxford-street, made by Messrs. Strode, from I believe the architect's design. Its merit is slightly lessened in my eyes at all events, from the fact that it appears to some extent to have been inspired by the example just seen. Of signs made for public houses, those for the Rising Sun in Tottenham-court-road, and the Shades in Charing-cross are by my own firm, to the order of Messrs. Treadwell and Martin. Being my own offspring the less said about these the better. The most original and daring sign yet erected is undoubtedly that for the same architects, by my friend Mr. Shirley. It is quite alone and very quaint. The only fear I have about it is that if many signs with so great a projection were erected in our streets, the privilege of putting up any at all might soon be abrogated.

DISCUSSION.

The CHAIRMAN said it was, he thought, accepted by antiquarians that the shop sign of mediæval Europe was of Roman origin. The Romans would appear to have advertised by shop signs, and among them signs indicating one's trade or calling were used with far greater freedom than would be tolerated in Christian Europe, as those would realise who had seen the Pompeian sign, or the illustration of it in the catalogue of the *Museo Borbonico*, with the legend, "Hic habitat Felicitas." The sign of the Golden Ham is certainly of Roman origin, as a late Roman, or early Italian stone slab with five hams sculptured on it has been found in Italy, and is supposed to have been the sign of a penarius or "hamseller," afterwards used as his grave stone. The emblematical sculptures on the cippi of Roman and Romano-Gallic tradesmen were obviously in many cases derived from their shop signs. A marble relief found in this country, and now in the Blundell Hall, representing the manufacture of wine, is said by some to be a Romano-British wine merchant's sign. Others, with some reason, the speaker thought, regarded it as a sepulchral sculpture. He frequently saw in this country over the shops of hosiers a twelve-spoked wheel with a ram hanging from it. This was really an astrological sign, representing the circle of the Zodiac with Aries hanging from it, the hoziers' "Sign." Every trade has its zodiacal and planetary tutelaries, and they provide excellent motives for shop signs. In India and throughout the East generally, such symbolical signs exercise a great influence over the people. We all know the trade mark on the bottles of Bass's ale, a triangle with the apex upward, and coloured red. So represented, it is the symbol among the Hindus of Siva, and of fire, and of the most powerful generative energy, and its use on Bass's bottles has immensely helped to popularise their ale among the Hindus in India. It is said that the new Appollinaris Company paid

Messrs. Bass £10,000 for the use of this symbol as a trade mark on their bottles. But so far as the sale of Apollinaris in India went, they would have done better to adopt the symbol of Vishnu, and of water, the symbol also of reproductive power, the triangle with its base upward, and coloured blue. The Messrs. Allsopp's "red hand" is a good brand for Mahomedan countries, but it would be better were the fingers arranged in the formula of priestly benediction, another most potent symbol of creative energy among the Hindus. The crossed triangles, known to us as "the Shield of David,"* and "the Seal," and "Knot of Solomon" is the symbol among Hindus of Brahma, and supreme creative [combined generative and reproductive] power, and would make a good trade mark, or shop sign for use, in India. The *swastika*, both the red, or right to left revolving, and the blue, or from left to right revolving, representing the revolution of the sun in the upper and nether [region of the Cape and Australian colonies, or Patala—the classical Hades] worlds respectively, is a symbol equally reverenced throughout the East by Buddhist, Hindus, and Mahommedans. The pentacle, pentangle, pentalpha, known also as the "Pythagorean Foot," the "Druid's Foot," [Drudden Fuss] and "Fuga Demonorum," is a most powerful talisman among Mahomedans, and is reverenced also by the Hindus; and its use as a trade mark, or shop sign, would be highly advantageous among Mahomedan communities, particularly in popularising among them goods against which they are traditionally prejudiced, such as wines, spirits, &c., pigskin saddlery, &c. The Hindu "nava ratna," or "nine gems" jewel, a symbol of the "Seven Planets" (the waxing, full, and waning moon counting as three), suggests a most picturesque motive for an illuminated shop sign. But it was too late in the evening to go on in that way, and he would at once proceed to answer the question in the first paragraph of Mr. Starkie Gardner's paper—Why had he (the Chairman) asked him to prepare it? Whatever sinister motives he might have had in so doing, he had two perfectly righteous ones; one being that he well knew Mr. Starkie Gardner would provide them with a paper worthy of its subject; and the other, that being unable to provide himself with "a house and grounds" suited to his exacting tastes, he was selfishly, as well as, he hoped, altruistically, interested in the tasteful and picturesque decoration of our streets, to which end artistic shop-signs were a comparatively cheap, universally useful, thoroughly national, and most effective means. Mr. Starkie Gardner had given them an excellent paper, full of far-brought learning, and, literally, "at-one's-door" suggestion, all stated in the most vivid and entertaining manner; and he felt perfectly certain that it would greatly tend to stimulate the growing demand among the higher class of London tradesmen, in every sort of business, for shop-signs of every variety and description. He did not understand Mr. Starkie Gardner's apparent objection to painted sign-boards. He seemed to think it derogatory to artists to paint sign-boards. But if the production of artistic shop-signs is to keep pace with the prospective demand for them, not only braziers and blacksmiths, but potters, and wood carvers, and painters, and even sculptors must all give a helping hand to the good and gracious work. Nothing was more detestable than vulgar advertisement, but advertisement was an absolute necessity of trade; it is an instinct of human nature, and it runs through all creation. The great thing, therefore, is to substitute for vulgar, and too often absolutely brutal advertisements, advertisements which are the best work of the best artists—whether of the "studio" or the "workshop"—of our day. Already our "public houses" are rendering great services in the gradual scenic improvement of the streets of London, and they should in every way be encouraged in this new departure. They are sure to profit by it. There is nothing more agreeable to a healthy man after a spell of any kind of hard work, mental or physical, than a draught of sound ale, and when he is invited to it by a homily, or quaint, or historic, or beautiful shop sign, the invitation is irresistible. There is nothing one more misses when abroad than the English country side inn, and on his return from India, having to settle in London, which was then a strange place to him, he was greatly delighted by finding in a shop in Westminster —in Bridge-street—given up to the sale of publications for the suppression of all sorts of vices, an admirable map of London, with every publichouse in this great city prominently marked on it in bright red. With its assistance, and taking parish by parish, it was wonderful to think of the number of London public-houses with which, in the course of twenty-eight short years, he had become personally acquainted. He had found them, for the most part, to be thoroughly respectable establishments, and the proprietors of all of them thoroughly honest tradesmen, judged, that is, by the goods they vended; for from Bayswater to Whitechapel, and from Highgate to Brixton, he had never once been served with a glass of bad ale. But their signboards were, for the most part, a terrible eyesore; and instead of being a source of attraction, were a cause often of positive repulsion. All vulgar advertisements, advertisements which instead of being subordinated to, and emphasising, the architectural features of a shop, obliterated them; which were flaunted against the skies, or set up obtrusively in the midst of beautiful scenery, or which in any way showed a brutal disregard of other peoples' susceptibilities and common rights, were instinctively obnoxious to the public;

* Neither books, nor Eastern tradition—certainly not Indian—sufficiently satisfy me as to whether the descriptive phrases, "The Shield of David," "The Seal of Solomon," both refer to the crossed triangles, or both to the pentangle [*not* pentagon] or pentalpha; or whether one ef the terms—I cannot decide which—refers to the crossed triangles, and the other to the pentangle. I believe the latter to be the "Seal of Solomon," and the former the "Shield of David," but cannot give chapter and verse for it. The decision of the Freemasons on this point, or on any point of Eastern symbolism, can never be convincing.

and were undoubtedly damaging to those who needlessly used them. He had no money of his own to spend, but he had spent immense sums of other peoples' money in advising them where to go for artistic objects; and he never recommended people who advertised vulgarly, for it was impossible to trust to the taste and judgment of such persons. On the other hand, a shop front, designed by a scholarly architect, with an artistic sign, whether it was a hatter's shop or a public house, was always the best of recommendations to the good things within. It was idle to run down advertisements simply because they were disfiguring and offensive; the proper remedy was to make them becoming and acceptable, as the publicans were so wisely doing; but this reform can never be adequately carried out without the co-operation of architects, sculptors, painters, and metallurgists. Mr. Starkie Gardner had led the way in the reform, and he should be all the better pleased if others than blacksmiths and braziers were found to follow him in the more enticing, and thoroughly popular method of shop embellishment, and street decoration, which had been his special contribution to the general Victorian Renaissance of art and artistic industry. He felt it a great honour to have presided on the occasion, and to be the channel through which the grateful thanks of the meeting were offered to Mr. Starkie Gardner.

Mr. John Leighton, F.S.A., said signs were at first intended for the ignorant who could not read, but the great thing now was to evolve something suitable for the well instructed. It was curious to notice how badly the rococo style went with metal, it being an agglomeration of disjointed elements thrown together, often very agreeable in effect, but at the same time it hardly seemed suitable for iron. It needed a lot of chiselling, and the great thing in iron work was to get smith's work, so as to utilise the metal as much as possible. The heraldic signs were very beautiful, and the sooner these who put up the royal arms substituted pierced ironwork for the present gaudily-coloured figures the better.

Mr. I. Hunter Donaldson said it was gratifying to find that signs were largely increasing in London, and they all knew how much they were indebted to Mr. Starkie Gardner, with his charming taste and thorough acquaintance with the best foreign examples, for the production of some of the most beautiful signs. He quite agreed with the Chairman that painting should be combined with iron work, and he could not conceive that Mr. Gardner would object to it, because the position which would under ordinary circumstances be occupied by writing could be filled up in the manner shown in Mr. Heath's sign. They were led to believe that some objection might be raised to signs if they became very numerous, and that they would interfere with each other, but he thought the County Council might be safely trusted to see that they were arranged in such order and good taste as to present an agreeable effect, without that confusion which would result and must have resulted from the agglomerated arrangement which appeared to have obtained in former years. He had seen many of these signs in foreign countries, particularly in Germany, where they were more numerous than in any other country, possibly because beer was so largely consumed there; certainly they were extremely beautiful, and he had examined many of them in conjunction with Mr. Starkie Gardner. In going about London they must be conscious that almost every important street presented some evidence of the increasiag taste of the English people for that art which had always been associated with the country and which ought to be highly prized. They had unfortunately a Government without an individual in it connected directly with the arts, and were therefore all the more indebted to gentlemen like Mr. Gardner who gave time, thought, and knowledge to the development of this taste. If we were to be redeemed from barbarity all such forms of art should be encouraged. The signs in all important streets gave evidence of improved taste in the people, and increasing enterprise on the part of shopkeepers.

Mr. W. G. Trewby said he understood the reader of the paper to say that the Jack-in-the-Green was connected with the sign of a public house, but his belief was that it was a representation of a forest scene, with Maid Marian dancing, the green being intended to represent the place where the dance was performed.

The Chairman—The truth is, the May mummery of "Jack-in-the-Green," like most other remotely derived popular celebrations, had several origins. It was undoubtedly connected with the old public house sign of the "Ivy Bush"; and it had become connected with the legendary history of Robin Hood and Maid Marian. But, earlier than all these, "Jack-in-the-Green" came down from the most primitive pagan times, and the annual celebration of the revival of vegetation between the Spring Equinox and the Summer Solstice—Midsummer Day. It is analogous to the festival of "Green George," *i.e.*, "St. George-in-the-Green," held in Corinthia on St. George's Day, 23rd April; with the Maypole festivities once universally observed in this country on the 1st of May; with the Whitsuntide floral [Pinxterbloem] festivities of Holland; and with the St. John festivities held in Sweden on the eve of St. John's Day (24th June), when young fir trees are set up before every house, and arbours are constructed of fir branches, and the people sit out in them, eating and drinking, all the night through. The fullest information on the subject would be found in Fraser's *Golden Bough*, and enough for the "general reader" in Mrs. J. H. Philpot's *Sacred Tree*.

Mr. STARKIE GARDNER, in reply, thanked the Chairman for the way in which he had spoken of his efforts with regard to ironwork, which had now been continued for more than twenty years. He had tried to do his best, and certainly there had been a most marked revival of the trade. When he started there were very few smiths capable of doing any artistic work—you could number them on your fingers—but now there were a large number, and he was happy to know that no skilled smith need ever want a day's work. The demand was still far in excess of the supply, and it had been most gratifying to him to find that this revival had led to quite a display of talent amongst the working classes, such as had hardly been expected in England, though it was common in France and Germany. He must certainly disabuse the Chairman's mind of the idea that he was in any way disinclined to see painting associated with metal work. It was not that he did not wish it, but it was exceedingly difficult to find capable artists who would condescend to paint signs at all. There was a beautiful sign in Vigo-street, "The Rembrandt's Head," which he very much admired, and should be glad to come across the man who painted it.

The CHAIRMAN then moved a cordial vote of thanks to Mr. Starkie Gardner, which was carried unanimously, and the proceedings terminated.

Miscellaneous.

*COMMERCIAL EDUCATION IN ENGLAND.**

By SIR HENRY TRUEMAN WOOD, M.A.

(Concluded from page 593.)

Examinations on somewhat similar lines have also been recently established by the London Chamber of Commerce, which grants certificates to candidates who pass in certain specified subjects. The standard of these examinations is somewhat higher than that of the Society of Arts, and they are, I think, intended principally for pupils at, or leaving, school. The number of candidates for these examinations has up to the present not been very considerable, but the certificates, are, I understand, valued by employers as a test of the candidates' qualifications. Examinations, which are practically examinations in commercial knowledge, are also held by Institutions such as the Institute of Chartered Accountants and the Bankers' Institute—these, however, are of a strictly professional nature, and form the qualification for membership of the Institutes.

It will thus be seen that, though there are in London—and the conditions in the provincial cities are similar to those in the capital—scarcely any institutions providing specialised commercial education, that city is by no means deficient in means for providing good primary and secondary education of a modern type. There exist a number of excellent schools where such education is provided at a moderate cost for boys up to the age of 14 or 16. There are also well-equipped evening classes or continuation schools where young people engaged in business during the day can continue their general education, and can also study subjects of a distinctly commercial character.

Whether such education is commercial education depends upon the meaning which is to be given to the term. Some people by commercial education mean a knowledge of business routine; others maintain that the only useful sort of training consists of a good grounding in general education, and that the knowledge of the business routine of any special trade must be acquired in the office devoted to that special trade. It has been remarked that the business man is not a genus by himself. Different training is required for the banker, the foreign merchant, the shipping agent, the railway official, and the insurance clerk; and of each of these, and of very many other classes, there are innumerable divisions — office boys, book-keepers, accountants, agents, travellers, managers, for each and all of whom a different preparation is necessary.

Again—the remark was made by Sir Bernhard Samuelson, the chairman of the 1881 Royal Commission on Technical Education—the methods of commerce are empirical. There is no pure science in trade. Here is the difference between technical and commercial instruction. Modern industry is based on science. Every branch of industry has its own associated branch or branches of science. These can be taught. What departments are there of science of which a knowledge is essential to the commercial employé? Of course, all—or any—knowledge may be useful to him, but that is only saying in other words that he wants a general, not a specialised, training.

The London County Council have recently rendered valuable service towards clearing up this question—the definition of commercial education—by the publication of a report on the subject by a sub-committee of the Technical Education Board of the Council. This committee took means to ascertain the opinion of a considerable number of typical employers of labour in London, and these opinions they have published, with a report of the conclusions which the committee themselves have drawn from the material they had collected. It is somewhat remarkable, considering the recent demand for commercial education on the part of employers, to find that the witnesses before the committee were practically unanimous in the opinion that for the lower grades of commercial employés special school training was undesirable. They all expressed their preference for a boy fresh from school, with the best elementary education, over the boy who would come a year or two later into the office, after having passed the

* A paper read at the International Congress on Technical Education at Venice, May, 1899,

additional time in acquiring a probably imperfect knowledge of so-called commercial matters, which possibly would have no application in their special house of business. An intelligent boy, they said, coming into the office at 14 would at 16 be far more valuable to them from the special knowledge he had acquired than a similar boy coming to the business at 16, with an imperfect equipment of so-called commercial education. It was urged that a few years later the boy who had had the more advanced instruction would then be the more useful of the two. This was admitted as possible, but, as a rule, the commercial experts seemed disinclined to allow even this much. They were, however, prepared to admit that boys, as a rule, left school much too early, and that it would be a great advantage if the school age could be extended for another year or two. But they were unanimously against early specialisation, and they one and all held to the point that, though it would undoubtedly be an advantage for boys to have another year or two's schooling, those years must be devoted to general education, not to instruction in commercial matters, or even to any attempt to acquire a knowledge of general business routine. It goes without saying that the education ought to be a modern one, and if classical languages were to be admitted, they were to have but a small part in it. Modern languages were important; book-keeping and shorthand should be included; and elementary mathematics were essential. All these subjects, too, should be taught with a view to their practical application—languages from a commercial, not a literary, standpoint, and all the other subjects in the same way. My own experience of the Society of Arts examinations leads me decidedly to the opinion that any attempt to teach special subjects at an early age is wasted, so far as they are taught with a view to their practical application. Even such a subject as book-keeping had better wait till, at all events, the end of the school age. Of the three or four thousand candidates who are annually examined in this subject—and these are certainly above the average of junior clerks—I do not think that much more than 10 per cent. would be found useful additions to the staff of the head accountant or book-keeper in a large firm. No doubt the preparatory training has been useful to all; but, at all events, in the case of the younger candidates, I am inclined to think that a further grounding in elementary mathematics would have been quite as practically useful, and would have proved a better mental training.

On the question of higher commercial education, opinion was very much divided. The system of carrying on sham commercial transactions at school, which is strongly advocated by many Continental authorities, and by some educational experts in England, met with scant support. It was considered that this was merely playing at business, and that the training so acquired would be of little use in practice. Some witnesses preferred for their higher posts, when these were not recruited from the lower ranks, University men; others considered that the last year or two of educational life could be best spent in a foreign country acquiring a knowledge of its language and its business methods. On the whole, opinion was favourable to such institutions as the London School of Economics, previously mentioned, in which special teaching could be given to those who had made up their minds what line of business they were about to adopt, or were even already engaged in it.

Eventually the Committee decided to recommend (1) the establishment and encouragement of continuation schools for those who entered business offices at about the age of 14, that is to say boys trained in the elementary schools; (2) that departments should be established in many of the secondary London day schools for the preparation for commercial life of boys leaving school at 16, the education to be given being of a general character—modern languages, arithmetic, and commercial geography; (3) that there should be formed in at least one secondary London day school of the first grade a department for the preparation for business life of boys leaving school at 18 or 19, the teaching of which should qualify its pupils either to enter the higher ranks of commercial life, or to pursue an advanced course of study in some institution of higher commercial education; (4) that in the reorganisation of the London University, which is now under consideration, provision should be made for the establishment of a separate faculty of economic and commercial science, to which pupils of Class 3 could go.

On looking over what I have written, I find that it bears a great similarity to that ancient worthy Horrebow's celebrated chapter on "Snakes in Iceland," and that my remarks have been, in the main, a demonstration of the non-existence of any provision for commercial education in England. As regards higher specialised commercial education, this is certainly the case. There are no institutions with this object in England, or none at least which have passed beyond the experimental stage. But, as regards the provision of general education of a modern type, which is, at all events, an excellent preparation for commercial life, I think I have shown we are not lacking, and that our educational system is rapidly developing in the direction required. That it can so develop in any required direction is, I think, a special advantage of its free and unfettered condition. That our system is sadly unsystematic must be admitted, and this leaves it very open to criticism on the part of our more logically-minded continental friends. I know that our happy-go-lucky methods are abhorrent to accurate thinkers and persons of a logical turn of mind. I hardly dare to suggest that they have any merits, but I may perhaps point out that they have their practical advantages. The English method, like the system of natural philosophy elaborated by our great thinker, Darwin, depends upon and encourages the survival of the fittest. Ultimately good results are attained, though possibly after a wasteful expenditure of material, and a painful

result to many of the individual components of the material. As the demand for a different class of education—first in science, then in scientific technics, now in commercial technics—has arisen, that demand has been, or is being, more or less adequately supplied. I have myself no doubt that in a short time we shall develop a system of commercial education sufficient for our needs, and of practical value. It will be theoretically incomplete, it will not commend itself to the admiration of the philosophical expert, but it will, I believe and hope, turn out excellent practical results.

Correspondence.

LONG DISTANCE TRANSMISSION OF ELECTRICAL POWER.

In a paper of mine, published in the number of the *Journal of the Society of Arts*, dated November 25th, 1898, some tables are given for facilitating calculations connected with the transmission of electrical energy to a distance. In Table III., the column of current densities, with an inefficiency of 1·3, is wrong, and, as these tables may probably be copied, I desire to give the correct values of the current densities at the inefficiency 1·3 for the different distances and electric pressures, indicated by the reference letters A to K. These are as follows:—

A	1064	D	266	G	152
B	532	E	215	H	133
C	355	F	177	K	89

GEORGE FORBES.

34, Great George-street, Westminster, S.W.
June 1st, 1899.

Obituary.

ARTHUR R. COWDROY.—Many members of the Society will regret to hear of the death of Arthur R. Cowdroy. He was for many years the library clerk of the Society, and in that capacity will have been well known to those members who make use of the library. His connection with the Society of Arts was a long one, dating from 1869, when he was engaged as an assistant to Mr. S. T. Davenport, at that time the financial officer of the Society. Very soon afterwards the library was placed in his care, and he has since that date been practically in sole charge of it. For some years past he was in failing health. He suffered from a nervous disorder, which developed into locomotor ataxy. He bore up against this with very great fortitude; but his illness lately assumed a more acute character, and after a short period of suffering he died on Thursday, the 1st of June. He was the eldest son of the late Rev. J. Rathbone Cowdroy, of Liverpool.

General Notes.

RUSTCHUK INDUSTRIAL EXHIBITION, 1899.—An industrial exhibition, which is to be opened at Rustchuk on August 14th, has been organised by the Ministry of Commerce and Agriculture, under the patronage of Prince Ferdinand. It will comprise machines, motors, apparatus, tools, implements for every industry and handicraft, including agriculture. Applications for information should be addressed to the manager of the exhibition, Mr. Arthur Gobiet, Prague, Carolinenthal, Bohemia.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 12...British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, JUNE 13...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.
Photographic, 12, Hanover-square, W., 8 p.m. Prof. Vivian Lewes, "Acetylene."
Anthropological, 3, Hanover-square, W., 8½ p.m.
Asiatic, 22, Albemarle-street, W. 4 p.m.

WEDNESDAY, JUNE 14...Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.
Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

THURSDAY, JUNE 15...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. R. T. Günther, "Contributions to the Natura History of Lake Urmi and its Neighbourhood." 2. Dr. A. B. Rendle, "A Systematic Revision of the Genus Najas." 3. Mr. Walter E. Collinge, "The Anatomy and Systematic Position of some recent Additions to the British Museum Collection of Slugs." 4. Mr. J. E. Duerden, "The Edwardsia Stage of Lebrunia, and the formation of the Oesophagus and Gastro-cœlomic Cavity."
Electrical Engineers, Natural History Museum, South Kensington, W. Conversazione, 9 p.m.
Historical, 28, Jermyn-street, S.W., 8½ p.m.
Numismatic, 22, Albemarle-street, W., 7 p.m. Annual Meeting.
Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. H. Sodeau, "The Decomposition of Chlorates, with special reference to the Evolution of Chlorine and Oxygen." 2. Dr. A. Harden, "The Action of Hydrogen Peroxide on Formaldehyde." 3. Messrs. A. Lapworth and E. M. Chapman, "Homocamphoronic and Camphononic Acids." 4. Mr. A. Lapworth, "Action of Silver Compounds on A-Dibromocamphor." 5. Mr. A. G. Perkin, "The Colouring Matter of Cotton Flowers." 6. Messrs. H. A. Auden, W. H. Perkin, jun., and J. L. Rose, "Experiments on the Synthesis of Camphoric Acid." 7. Mr. W. T. Lawrence, "Methylisoamylsuccinic Acid." (Part I.)

FRIDAY, JUNE 16...Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p m.

Journal of the Society of Arts.

No. 2,430. Vol. XLVII.

FRIDAY, JUNE 16, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Forty-fifth Annual General Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 28th June, at 4 p.m.

(By order of the Council),

Henry Trueman Wood,

Secretary.

CONVERSAZIONE.

The Society's *Conversazione* will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, 20th June. The reception by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman, and other members of the Council, will commence at 9 p.m.

The following portions of the Museum will be open:—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery; on the First Floor—the East and West Corridors.

A selection of music will be performed by the String Band of the Royal Artillery in the Central Hall, and by the Red Hungarian Band in the Bird Gallery, commencing at 9 o'clock.

Each member is entitled to a card for himself (which will not be transferable), and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the date of the *Conversazione*. On that day the price will be raised to 7s. 6d.

These tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary) or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied.

The entrance to the Museum is in the Cromwell-road. Carriages must enter the grounds by the east gate and leave by the west gate. The cards must be given up on entering the Museum.

Visitors arriving or leaving by either of the Metropolitan Railways will be allowed the use of the District Company's Subway, which leads from the South Kensington Railway Station direct into the grounds of the Museum.

Fuller particulars as to the musical and other arrangements will be given in the Programmes which will be distributed on the evening.

The cards of invitation have been issued to members.

Proceedings of the Society.

INDIAN SECTION.

Thursday, June 1, 1899; the Earl of Elgin and Kincardine, K.G., G.C.S.I., G.C.I.E., in the chair.

The Chairman, in opening the proceedings, said Sir Charles Stevens having filled the high office of Lieutenant-Governor of Bengal he could speak with great authority on the subject he had chosen. He had also sat in the Legislative Council of the Governor-General for several years, and the other members were accustomed to look to him for guidance in all matters appertaining to Calcutta. He would take this opportunity of saying that it always seemed to him that it was Sir Charles Stevens's great knowledge of the place and the people, coupled, of course, with his own sound judgment and fairness, that enabled him to deal so successfully with the time of disturbance which occurred while he was in office, and which, in less capable hands, might have had very serious results. He need not say much with regard to the interest attaching to the Port of Calcutta. Any one looking at it from a geographical point of view would be interested to know how it

came about that a port to which the only access was a tortuous channel where navigation was notoriously difficult and dangerous, should be unrivalled in the commerce of the eastern side of the Indian Peninsula. The student of history would also find much room for speculation as to how the small Bengal village of 200 years ago had now become the first city, politically and commercially, in the Empire of India. He must leave these matters to the reader of the paper; but from his own experience he might say that when he went to India, in 1894, there were many prophecies as to the future of Calcutta, some of them not very hopeful. Some were inclined to regard the Kidderpore docks as a white elephant, which would strangle the trade. It appeared to him then that the amount of coal shipped at those docks was extremely small, and he could not help thinking that it only required time for trade to develop in the same manner that dock accommodation had accomplished in other countries, under somewhat similar conditions. Any anticipations he had then formed had been more than realised by the result, for he believed trade in coal had been trebled since that time. He could not venture to say what the cause of that rapid increase had been. It had been suggested that it was contemporaneous with strikes in England, which could not be without their effect on commerce, even so far away. He had no doubt that there was every prospect of a great development of the coal trade in Calcutta in the immediate future, because the railway from the south which formed the last link of the East Coast Railway was now rapidly approaching completion. It was designed to open out fresh coal-fields, and all coal for export purposes must find its way to Calcutta. He could not forbear saying a word on one cause of anxiety for Calcutta, viz., that it was not now, as it was when he left India, free from plague; but even there there was cause for congratulation. Although the plague had come there it had never spread as it did in other places, and the confidence that now prevailed in the administration would encourage the people there in the belief that the Government would do all that it could to keep the plague in check, and with some reasonable hope of being successful. These points appealed to everybody, but those whose duty it had been to spend part of their lives in Calcutta, would feel a still greater interest in this subject. No one who had witnessed the scene on the Strand in Calcutta at sunset could carry away anything but a memory of beauty. There was there, no doubt, as there was elsewhere, the smoke nuisance, and he could not help thinking that the local authorities might be compelled to do something to mitigate it, and they had all the noises and inconveniences of a busy place. But still it was a scene where the bustling steamer of to-day was found side by side with the more graceful lines and tall spars of the sailing ship of the past; and he could not but think that many would have realised that this was a type of the manner in which the energy and enterprise of our countrymen had found an outlet. That energy and enterprise which had done so much to create the Calcutta of the present, would do much to maintain its pre-eminence in the future.

The paper read was—

THE PORT OF CALCUTTA.

By Sir Charles Cecil Stevens, K.C.S.I.

When it was suggested to me that I should read a paper at one of the meetings of this Society my choice fell upon the subject of the Port of Calcutta; for, though I have not the advantage of being an expert in any of the several branches of the administration of the port, I had, as Chairman of the Commissioners for some five or six years, a strong interest in that administration; and, further, I reflected that, notwithstanding the superficiality of my own knowledge, I might serve the purpose of eliciting discussion by other members better informed and more capable of being useful to you than myself. Conscious, as I thought myself at the outset, of the complexity of my subject, I realise it more fully now that I am undertaking to deal with it, and I feel that I ought to ask you beforehand not to be surprised if I omit or treat inadequately topics to which time and consideration might well be given. I propose to sketch rapidly the circumstances which led to the establishment of the Port of Calcutta; next, to compare the trade of the present day with that of early times; I then will show you, shortly, the constitution of the authority which has to manage the affairs of the port, the remainder of my paper will attempt to explain, though partially, some of the difficulties connected with the river Hugli, and the suggestions which have been made for their evasion, mitigation or removal; and I will lay before you, as well as my limits of time and capacity may permit, two important schemes which are now under consideration.

I think that the popular notion of the origin of Calcutta is pretty accurately conveyed by the following lines from some verses called "A Tale of Two Cities" by the most popular poet of the day—Rudyard Kipling.

> "Once, two hundred years ago, the trader came,
> Meek and tame.
> Where his timid foot first halted, there he stayed,
> Till mere trade
> Grew to empire, and he sent his armies forth
> South and north,
> Till the country from Peshawur to Ceylon
> Was his own.
> Thus the midday halt of Charnock—more's the pity!
> Grew a city.

As the fungus sprouts chaotic from its bed,
So it spread.
Chance-directed, chance-erected, laid and built
On the silt."

Very different, and (I venture to think) not inferior for the purposes of a poet, is the true history of this great metropolis!

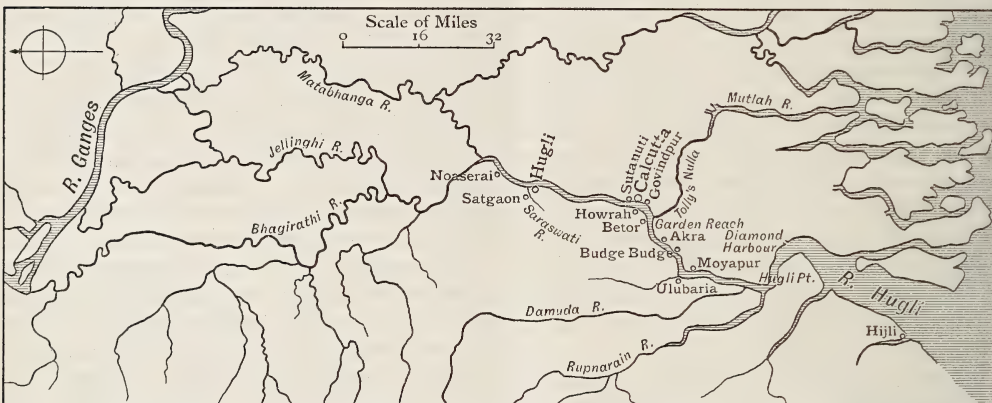
Though the Port of Calcutta is comparatively modern, its very name only having come into use scarcely two centuries ago, it is certain that from remote antiquity an important trade centre has existed in the lower part of the western mouth of the Ganges. Not only local products, but silks, raw and woven, from China found their way round by sea to the Malabar Coast, and probably further; and the oldest records of more modern times show that both in the eastern and western points where the great river met the sea there was very much activity, whether in the way of legitimate trade or of piracy, which preyed upon that trade but could not destroy it. This activity in both directions was considerably augmented by the Portuguese, who, in the early part of the 16th century, found their way to Chittagong on the east, and Sátgáon on the west—the former being named by them Porto Grande, or great harbour, and the latter (the precursor of Calcutta) Porto Piqueno, or little harbour—and enjoyed for more than 100 years the monopoly of the direct European trade, which the discovery of the sea route round the Cape of Good Hope had made possible.

Sátgáon, now represented by a few huts and the remains of a mosque (a relic of its later days under Mohammedan rule) was situated a few miles north-west from the town of Hugli, on the banks of the Saraswati, which, by tradition as well as probability, was once the chief western branch of the Hugli River. When the Portuguese came they were unwilling to expose their seagoing ships to the risks attendant on the navigation of the upper parts of the river, and anchored them in Garden Reach opposite a village named Betor, where huts were annually built for their accommodation, and destroyed after the despatch of the season's fleet. At this place the cargoes from Europe or the Spice Islands were discharged and sent up in country boats to Sátgáon; and the return goods (of far greater value) which had been collected at Sátgáon and the neighbouring marts, were brought here for shipment. The river at Sátgáon gradually silted up, and some of the native merchants began to desert it, and come lower down the river to meet the trade. Among others were four families of Bysakhs and one of Setts, who cleared the jungles and founded the village of Govindpur on the left bank of the river Hugli, nearly opposite Betor, besides establishing a mart for cotton goods at a place which they called Sutanati, a little higher up. Sutanati was near where the Calcutta Mint and the Mayo Hospital now are, while the site of Govindpur is at present occupied by Fort William and Hastings. It may be pointed out as an advantage in the position of Govindpur that it was close to the trade route served by the branch of the Hugli which is now called Tolly's Nullah, but was at one time the main stream of the Ganges, and is to this day regarded by the Hindus as their holy river.

As Sátgáon became more and more incapacitated for commerce it was abandoned for Hugli, which enjoyed the advantage of being on a river still navigable. The Portuguese were permitted to settle there, and Betor disappeared from history, the site being utilised for the erection of the Tanna Fort, which, with another at Matiyabruj opposite, was built as a defence against the native and Portuguese pirates from Arracan and Chittagong, of whose misdirected energies a testimony remains to us in the "Rogues' River" and "Thieves' River," marked on the oldest English maps.

At length, in 1650, some servants of the East India Company were deputed from Balasore, where a station had been made 17 years before, to Hugli for the purpose of opening a trade. The way had been, in a measure, prepared for them by the misfortunes which had fallen upon the Portuguese on the spot through their own ill-behaviour, and by the diminished interest which was now taken in Portugal in Indian affairs. I need not enter into details of the history of our settlement at Hugli; it is sufficient to say that the bravery of our sailors, and the honesty and growing enterprise of the merchants, made them generally welcome; but they became a mark for the rapacity of the native administrators, especially those who were on the spot and could cause immediate annoyance. In the course of 30 years the position became unbearable; and whatever may have been the jealousies and quarrels of the East India Company's servants among themselves, they all agreed in the opinion that it was necessary for them no longer to remain defenceless, depending only on the forbearance of the native authorities, and that they must follow the example of the Dutch and Portuguese, and establish a fortified settlement—such indeed as the Company itself had already

acquired at Bombay and Madras. By no one was this opinion held more strongly than by Job Charnock, who had by this time come to Hugli after 20 years' service under the Company. He stood very high in the favour of his employers, and the eulogistic terms in which they always spoke of him—except when they did not agree with him—were in marked contrast with the singularly frank and uncomplimentary language which they were in the habit of using to, or concerning, their other servants. "A person" (they call him) "that has served us faithfully above 20 years, and hath never, as we understand, been a prowler for himself, beyond what was just and modest." There is no doubt that he was a man of ability and discernment, and that his long experience up country had enabled him to gauge accurately the influences which were working to disintegrate the Mogul Empire. The Court of Directors concurred as to the necessity for active measures, and a squadron was sent out to Bengal. A somewhat serious engagement ensued, in which, however, the English suffered but little loss; and the native governor of Hugli was only too glad to let them leave that place, when it suited their convenience to do so. Charnock took the forces to Sutanati, and halted there for some two months. In the meantime, the Nawab at Dacca renewed hostile measures; and Charnock, after taking the Tanna forts, and doing other mischief, abandoned that part of the country as too high up the river to be tenable. He then removed to Hijli, near the mouth of the estuary of the Hugli river, and took possession of that place with a small fort of very little strength. After a short time, the English were attacked and besieged by an enormously superior force of Mogul troops; but by force and stratagem they held their ground for more than three months, and tired out the enemy. Terms were agreed upon; and a promise was given that the English should be permitted to go once more above the forts, and that the ratification of the agreement which Charnock had proposed at Sutanati should be obtained. These promises were not kept, and from Hijli the English went to Ulubaria. Here they remained for three months; but, finding this place unsuited for a settlement, they returned by consent of the natives to Sutanati, or Chuttanutty (as they called it); but Charnock informed the Captain-General of His Majesty's Land and Sea Forces in the North of India, of his firm resolution "not to settle noe trade" till the Sutanati articles should be confirmed, and some security given against any demands that might arise afterwards on account of damages. He was indeed sensible that he had caused an amount of damage, which (to use his own word) was "irrepairable" by him, and that "vast numbers of complaints" had been brought against the English to the Durbar. They stayed at Sutanati for over a year this time. Meanwhile, the Court of Directors, being dissatisfied with what had been done, sent out a powerful force, under a certain Captain Heath, with instructions to capture Chittagong. But the letters of the Court show that they had some misgiving owing to their want of knowledge, and that they were willing to accept any place which Charnock might already have settled and fortified; they say that since he "likes Sutanati so well," they were "content that he should build a factory there, but with as much frugality as



Walker & Boutall sc.

ESTUARY OF THE HUGLI.

may be." Heath, however, against the advice of the Agent, and the majority of the Council, persisted in breaking up the settlement, and proceeding to Chittagong. The expedition proved a complete failure, and six months were spent in fruitless undertakings. At length the Emperor Aurangzeb, fearing that the English contemplated the withdrawal of their trade, and perhaps apprehensive of active mischief from them, caused them to be invited to return. Eventually, after further negotiations, they once more came back to Sutanati, and proceeded to erect, as necessity required, and as cheaply as possible, the humble buildings of mud and thatch which were indispensable for immediate occupation. A few years later, the fort, which had been desired so much and so long, was commenced at Calcutta—a village between Sutanati and Govindpur, where the Post-office now is—and, about the year 1700, the Settlement was for the first time called Calcutta. And long may it prosper as the capital of her Majesty in India!

It is with difficulty that I have restrained myself from entering much more minutely into the fascinating history of these early days. But for this I must refer you to the excellent book by Professor Wilson, of the Bengal Educational Service, on the "Early Annals of the English in Bengal." My obligations to this compilation are none the less, because I have myself studied nearly all his authorities, besides others (I think) which he has not mentioned. I have written so much as I have in the hope that I may assist him in correcting the very prevalent error that Charnock founded Calcutta (as it were) by accident, and that a few merchants, putting on an appearance of simple trade, insidiously by degrees made themselves masters of the country. It was by no such tactics—at any rate, in their dealings with the local chiefs—that our countrymen made their way. At the very beginning of operations in Cuttack, the boldness, not to say audacity and arrogance, of the merchant Cartwright impressed the Governor and obtained concessions for trade; and in all the history preliminary to the founding of Calcutta, I can find no indication of concealment of our national characteristics. The selection of the site itself was most deliberate, and was adhered to by Charnock with great tenacity. The soundness of his judgment has been amply confirmed.

It is impossible to form any very definite idea of the volume of trade either in ancient times or in our own earlier days. Cesare dei Federici, a Venetian merchant, who started on his Eastern travels in 1565, and visited Sátgáon, wrote in Italian a short account of his journeys. He describes how the Portuguese traders used to go about from market to market buying goods, and tells us that every year 30 or 35 vessels were laden with rice, cotton cloths of various kinds, great quantities of sugar, myrobalams, long pepper, butter (I suppose ghee), oil, and many other wares. And he tells us that in the harbour of Orissa (apparently the now silted-up harbour of Harishpur Garh), 25 or 30 ships, large and small, used to take in cargoes of rice, different cotton cloths, oil of "zezelin" (made of a kind of seed), butter, lac, long pepper, ginger, myrobalams, and cloths of "erba" or tussur silk. But we have no information as to quantities, values, or destinations.

The first English ship intended for Hugli was the *Lyoness*, despatched in 1650; but the agents at Madras would not permit her to attempt the navigation of the river to that place, and she was sent only as far as Balasore with a cargo of money and goods, valued at £7,336 17s. 5d. How much of this actually reached Hugli I am not aware. We learn from "Bruce's Annals" that, in 1668, the Bengal Stock was of the value of £34,000. But I have not been able to discover any means of estimating the value of the trade of other European nations or of the natives themselves.

We cannot afford time to attempt to trace with minuteness the gradual development of the trade of Calcutta, however interesting such a task might be. Though gradual, it was rapid. In 1682, the stock from Bengal was £230,000. In 1795-6 (a little more than a century from the foundation of the city), 170 ships, of a total burden of 57,696 tons, came to the port from places outside the territories of the three Presidencies, and 184 ships, with an aggregate tonnage of 67,785, went out to such places. In the same year the total value of the inward trade, including that from the coast, Manila, China, Penang, and New South Wales, was estimated at £1,563,200, and the outward at £3,778,704. There was a considerable fall in the next two years, doubtless the result of European politics. The opening of the trade in 1813 caused a great increase in the tonnage, so that in 1817-18, 428 ships, with an aggregate tonnage of 161,346, arrived from beyond Indian limits; but this increase was not maintained. Twenty-five years later, however, the average number of ships entered inward was 646, with a total tonnage of 262,251,

and the average value of the imports and exports taken together, including opium and treasure, for the years 1841-3, amounted to 14 crores and 59½ lakhs of rupees, or nearly three times the total of 1795.

I should have liked to be able to give you the figures of the shipping for the official year just past, but there has not been time enough to obtain them. In the year 1897-98, 1,102 seagoing steamers, with a gross tonnage of 3,311,415, and net 2,116,940, entered the port, and 1,097 such steamers, of 3,275,685 gross and 2,097,895 net tonnage, left it; besides these, 133 sailing ships, of 250,958 gross and 237,477 net tonnage visited Calcutta, and 126, of 232,586 gross and 219,808 net tonnage, went out. The gross tonnage entering the port was thus no less than 3,562,373, or more than 13 times as great as in the average of the years 1841-3. The average had increased from 330 tons (including only the foreign traders) in 1795, 377 in 1817, and 405 in 1841-3 to upwards of 3,000 for steamers and nearly 1,900 for sailing vessels. The average gross tonnage of steamers from European ports *viâ* the Suez Canal in 1897-8 was no less than 4,033. Thirty years ago more than three sailing vessels to one steamer entered the port; in 1897-8 there were more than eight steamers for one sailing ship. The influence of steam is as evident in the case of sailing ships as in that of steamers, since powerful tugs are now available and make it possible for much larger ships than formerly to use the river with safety. Since 1870 the average tonnage of sailing ships has nearly doubled, while that of steamers has increased by more than 237 per cent. I am not quite certain of the tonnage of the largest steamer which uses the port, but I think it exceeds 6,500. It is difficult, with these figures before us, to realise the hesitation in old days to bring ships of 400 or 500 tons up the river.

The kindness of my friend Mr. Baker, Collector of Customs (and now, I am glad to say, acting as Secretary to the Government of Bengal, and a member of the Provincial Legislative Council), has placed in my hands some statistics, as yet unpublished, of the trade of the year just passed. The total value of the imports from foreign countries alone, without counting the coasting trade, was no less than Rs. 29,65,21,828, and that of the exports Rs. 44,98,66,582; the total foreign trade thus amounted to nearly 75 crores of rupees, or, at the present rate of exchange, about 50 millions sterling. I have not the totals of the coasting trade. In 1897-8 above five-sixths of the total trade was with foreign countries, and the remaining one-sixth with coast ports; but the latter trade was in that year somewhat abnormally swollen by the movements of grain in consequence of the famine, while foreign imports, in some respects, were injuriously affected by the inability of the poorer classes to pay for them.

In the past year cotton fabrics were by far the most important class of goods imported—a singular reversal of the old course of Indian commerce. Cotton goods account for nearly half the total. Sugar, too, instead of being, as it once was, a large item of export, was imported to the value of nearly 113 lakhs. The importations of salt, which in the old days was made in Bengal, but a considerable proportion of which now comes from Red Sea ports, were worth 52 lakhs. Machinery and railway plant together were of the estimated value of nearly 200 lakhs. The imports of gold amounted to 2⅓ crores of rupees.

On the export side, too, we see great changes from the course of the old commerce. Jute, raw and manufactured, is now by far the largest item, contributing over a quarter of the total. Even this is much below the ordinary proportion, as there was but a poor crop last year. In 1897-8 the value of raw jute exported was, as nearly as possible, one quarter greater. Next comes tea, which was valued at nearly 757 lakhs; hides and skins accounted for nearly 383 lakhs, and seeds (chiefly linseed) for 411 lakhs.

The exports of seeds were unusually heavy, as the trade was stimulated by failures in La Plata and Russia. The recovery of the trade in rice after the famine, and the high prices of wheat in Europe, caused the item of grain and pulse to rise to the aggregate value of over 522 lakhs of rupees. Of the old staples, opium (432 lakhs), indigo (187 lakhs), lac (86 lakhs), silk (53 lakhs), and saltpetre (34½ lakhs) are the chief that remain. But none of these appear to be in a very flourishing condition, though the attention now being paid to silk culture may have a good effect. The ancient export of very fine cotton cloths, which was once perhaps the most famous of all Indian products, is no longer prominent, if indeed it survives at all. Sugar is but a trivial item—but a small fraction of the value imported.

But a new industry, which has suddenly sprung up, and has grown with astonishing rapidity, is coal-mining. In 1896-7, the exports were 678,580 tons, foreign ports taking about a quarter of the quantity sent to coast

ports. In 1897-8, the total had increased to 1,136,606 tons (the coasts taking a rather larger proportion than before); and, in 1898-9, to a million and a quarter tons. The development of this trade is said to have been assisted by the restriction, in 1897-8, of the output of collieries in Japan, imposed in order to prevent inconvenience in the event of fuel being required for warlike purposes. The Straits Settlements, therefore, have had to indent on Bengal, and the trade is likely to be maintained. For the present, the limitation of the coal trade of Calcutta seems to arise from within the province rather than from without. It has hitherto been determined by the insufficient capacity of the railway to carry the immensely-increased output; but I understand that measures have been taken with the view of providing greater facilities. Raw cotton (68 lakhs of rupees) and twist and yarn (52 lakhs) are the most important of the remaining exports.

The Mohammedan rulers of Bengal appear to have been active in imposing taxes on trade, though the nominal rates were low. We read in Hedges' Diary, of 1682, of "the severall affronts, insolencies, and abuses, dayly put upon us by Boolchund, our Chief Customer," or Collector of Customs at Hugli. But I do not find any record of beneficial regulation, or of improvement of the harbour or river. After the foundation of Calcutta, the first work which has come to my notice is the building of a wharf in front of the fort in 1709-10. In the Bengal "Consultations" for that year, it is said, "we" (that is to say the Council) "find 'twill be a great security to the banks, and a strengthening thereto; 'tis therefore agreed we instantly sett about it, and make it with brick, and raise a breast-work to plant cannon there." A few years later, we find from the letters of the Court of 1727 that the river had been giving trouble, as it does to this day, by cutting the bank on the north side of Calcutta. The Court, while sanctioning protective works, complain that these ought to have been undertaken when the river was "first discovered to gullup away the ground." Not much work of this kind was done for a very long time. A writer, in 1853, says:—"Quays for the approach and use of shipping do not exist in Calcutta, neither are there any fixed landing stages, jetties, or floating piers; partly, perhaps, owing to the questionable nature of the riverside foundations, and the objections to attaching vessels to a quay-wall during the bore, and also from a general absence of energy and enterprise in the local commercial interest." Moorings, lights, and surveys had, however, been provided, and were well managed by Government, though in a manner which is said to have been "devoid of all the self-improving energy which characterises the institutions of Great Britain."

One reason why the banks remained in a natural state was that "a general and indefinite idea was current that a comprehensive plan would some day be devised for securing greater advantages." Indeed there had been much talk of such improvements, and some were actually carried out; but though Government was far from unmindful of these things, its attention was distracted by too many cares to be fixed with sufficient steadiness on the affairs of the port. At length, in 1870, an Act was passed authorising the appointment of Commissioners for making improvements in the Port of Calcutta; they were created a corporation; and the powers and trusts created and declared by the Act were vested in them. Powers for executing certain classes of works were bestowed on them, and authority was given to Government to confer on them, with their consent, the office of Conservators of the Port, including its approaches. This office was made over to them by notification in 1881; and, with the exception of pilotage fees and hospital dues, all port dues and fees payable under the Ports Act were transferred to their disposal. Changes have been made in the law from time to time which I need not detail. Under the present constitution the Commission consists of a Chairman and Vice-Chairman, appointed by the Government, and 13 other Commissioners, of whom five are elected by the Chamber of Commerce, one by the Trades' Association, one by the Bengal National Chamber of Commerce, and one by the Calcutta Municipality; five are nominated by the Government.

The Government's power of nomination is so exercised as to represent the East Indian Railway and the Eastern Bengal Railway; one nominated commissioner is a merchant, and there are only two official members besides the chairman and vice-chairman. One of these is the Collector of Customs and the other the local head of the Indian Marine. The official functions of both these officers qualify them to render very useful service on the Board. All the remaining members directly represent trade and commerce. The chairman has hitherto been one of the members of the Board of Revenue, the highest executive officers under the Provincial

Government. Not he, however, but the vice-chairman, who is also chief engineer, is the chief executive authority by law, though in practice I used to be largely consulted. The constitution of the Port Commission is sometimes criticised; but I do not think that much practical evil has arisen from such defects as may exist. In the complicated conditions of modern trade it is not possible that every branch can have its representative: but in later times, both the President and Vice-President of the Chamber of Commerce have been Commissioners—greatly to the advantage of both the merchants and of the Port work. For these gentlemen, being at the head of the Chamber, with all its branches and 13 affiliated associations, are in a position to bring before the Commissioners the needs of any department which may not be directly represented. And I cannot mention the Chamber of Commerce without an acknowledgment of the immense service which this distinguished and very ably conducted society is performing in Bengal, not only by promoting and regulating trade, and carrying self-government still further than the Port Commissioners can do, but also by assisting the Administration of the Province with advice and support in affairs of importance.

The work of the Port Commissioners now comprises, with the exception of the pilot services and one or two other departments, the whole charge of the port, which extends for nearly 20 miles from the north of the city to Budge-Budge, at which latter place arrangements have been made for the import and storing of petroleum. They have also to provide for the lighting and survey of the approaches to the port. Their business is divided in the accounts into eight parts, viz.:—Jetties (including the tea warehouses, where tea is received, stored, examined, and, if necessary, re-packed, and the petroleum jetties and stores), inland vessels' wharves, harbour-master's department, Strand Bank lands, new works, Port Trust Railway, port approaches, and dock revenues. The income of the port in the above departments, supplemented by a special toll on imports and exports, which it has been necessary to impose to pay for the dock, amounted in the year 1897-8 to Rs. 61,84,908, or five times that of the year 1872-73, the earliest for which accounts in their present shape are available. The items of railway, port approaches, docks, and special toll, of course do not appear in the accounts of 1872-3; without them the remaining items grew in 1897-8 to about twice and a half what they had been in the former year. I am glad to say that, up to the end of January last, the latest accounts which I have seen show an income for the year 1898-9 of no less than Rs. 51,64,980, or Rs. 1,31,291 more than up to the same period of the year before. The value of the block and reserve funds (without estimating anything for the valuable Strand Bank lands, which are rented from Government) amounted at the end of 1897-8 to Rs. 5,64,04,508. The total amount of outstanding debt due from the Port Commissioners was at the same period (allowing for investments made to meet debentures) Rs. 4,09,50,346, including Rs. 2,87,70,566 due to Government for the construction of the dock. Ninety-two and a-half lakhs had been obtained from the public, and lately another $12\frac{1}{2}$ lakhs were borrowed. The three loans previous to the last were obtained at 4 per cent. and a premium of from Rs. 5 12 a. 6 p. to Rs. 9 per cent. was received. The present price of these stocks in the market is 106; the last loan was at $4\frac{1}{2}$ per cent., and was issued at 107 premium. When money is required the offers are largely in excess of the sum needed. The credit of the Port Commissioners stands next to that of the Government itself; and it is only the general stringency of the money market which prevents these loans from reaching a higher price.

I regret that the limits of what is reasonable do not permit me to enter into details of the various arrangements which have been made from time to time by the Commissioners to meet the public convenience in the several departments. Not to speak of many minor works, they have doubled the extent of the jetties, and greatly improved them, and have built tea warehouses and petroleum jetties and sheds, and laid down moorings at Budge-Budge. Their greatest work has been the construction of the dock at an initial cost of nearly two millions sterling. Since this dock was completed, according to the original plans, they have made large and important additions, with the view of utilising it further and increasing its conveniences; especially (as I shall show later on) they have endeavoured to provide accommodation for the salt trade, and the expansion of the coal exports. They have much improved the lighting and the survey work; and the bad portions of the river are now incessantly examined, and the pilots immediately informed of changes. In 1897-8 the additions to the block consisted of many

items, and cost upwards of fourteen lakhs of rupees. The Commissioners have now under consideration other schemes of great importance, which I propose to lay before you, with such explanation as will, I hope, make their nature and object clear. These have to do with improvement in the river, and extension of the accommodation for vessels in port.

It will be remembered that in the days of the Portuguese the foreign ships did not go higher up the Hugli than Garden Reach. Though our own trade with Bengal through Balasore began in 1633, English ships did not attempt the navigation of the river till long afterwards. I have already mentioned the voyage of the *Lyoness* in 1650, which was intended to proceed to Hugli. The agents at Madras discussed the project on her arrival, and "having" (as they say) "formerly understood that passage to be full of danger," unanimously voted against the ship's adventuring thither, and permitted her to go only as far as Balasore. The Court at home did not desist from urging their desire that their ships, instead of being discharged and grain-laden for England at Balasore, should be sent up the river, and their "businesse in the Bay" (as they expressed it) "brought into some decorum." In 1662 they agreed to pay 10s. per ton extra to the chartered ships for all goods that they should "take in within the said Barr of Ganges, and to be at the charge of Boats and Pylotts to attend up and doune the River, and in and out of the Barr." In the same year a Captain Elliott offered to take his ship up the Hugli, and pointed out that the Dutch ships of 600 tons performed this feat, which he declared to be "hazardless." This suggestion was commended to the local agents; but, though aware of the advantages to be gained, they sent no ship up the river, because they had no pilots. A small vessel called the *Diligence* was then built to assist ships in their navigation of the river, and in 1668 the Court renewed the offer of the bonus, and directed that "divers able persons" should be instructed as pilots, and that all persons in the vessels up and down the river, from the youngest to the eldest, should be "put upon taking Depths, Sholdings, setting of Tydes, Currents, Distances, Buoyes, and making of Draftes" (*i.e.*, maps) "of the river." They also, "for a supply of young men to be bredd up," entertained six apprentices on the encouraging salaries of £6 each for the first three years, £7 for the next two, and £8 for the last two. These magnificent allowances were to be "their provision of clothes," so it is to be presumed that they were fed by their masters. Ten years later the Court directed the enlistment for this work of any that might be willing "among the soberest of the young mates or midshipmen," just as at the present day the Port Commissioners recruit for their harbourmaster's department from young officers of ships; but these last are required to produce masters' certificates.

The first English ship to go up the Ganges was the *Falcon*, which, in 1678, conveyed to Hugli direct a cargo of bullion and goods valued at over £40,000. Eventually, as the river became better known, our countrymen became bolder; and in 1686, three ships, carrying from 50 to 70 guns each, ventured up to attack Hugli. Some 70 years later, Admiral Watson reached Chandernagore with ships of the line. These facts are interesting and important, for they tend to show that the Hugli has had a bad character for three hundred or more years, but that channels did exist so late as 150 years ago, which gave access, in cases of necessity, to sailing ships of considerable size, not only as high as Calcutta, but to places which could not now be reached by comparatively small vessels. There is, therefore, no doubt whatever of the deterioration of the river down to Calcutta; but no data exist from which this can be estimated, or from which we can draw any certain inference as to whether the process has reached its limit. I need hardly say that the Hugli is not an independent river, but one of the mouths of the Ganges, formed mainly by the confluence of the three offshoots of that great stream—the Bhagirathi, Jellinghee, and Matabhanga. The positions of the points of outlet of each of these vary much, from time to time, and their state and depth have also changed considerably under different conditions of the channel of the Ganges. Mr. Vernon-Harcourt (who, as I shall explain later on, specially studied the river) tells us, that in the case of the Bhagirathi, the inlet has varied since 1822, within limits no less than 23 miles apart. In olden times, these changes used to occur; for Rennell says that in the eight years of his experience (more than 100 years ago), this branch (the Cossimbazar river, he calls it) moved three-quarters of a mile. And I have found in the India Office some accounts still older — submitted in the early part of the last century—showing charges for the transhipment of saltpetre, which had come from Patna in large vessels into boats capable of passing down the Bhagirathi. These three

offshoots of the Ganges are collectively called the Nuddea rivers, and the ingenuity of the Bengal Public Works Department has been long taxed to the utmost to keep one or more of them temporarily open for boat traffic, which is very extensive. Their efforts have not always been completely successful, and it seems doubtful whether much, at least of a permanent nature, can ever be done to improve and control such inconstant streams. It is satisfactory, therefore, that Mr. Vernon-Harcourt has been led by the evidence before him to regard it as probable that all of them have improved somewhat of recent years. The main reason of the falling off of the river above Calcutta seems to have been the defection of the considerable stream of the Damuda, which used to flow into the Hugli, some distance above the town of that name, but is said to have suddenly, in the last century (I think in 1762), found a fresh outlet at Ulubaria, 16 or 17 miles south of Calcutta, and shortly afterwards at its present mouth (the Mundleghat of the old maps), nearly the same distance still lower down. I venture to hazard the conjecture that the consequent deterioration might have been greater but for the silting up of the rivers Jamuna, Bhoirab, and others, passing through the Nuddea and Jessore districts towards the south-east, which the Bengal Government, and still more, the local district officers, are constantly implored by the inhabitants to reopen. The Hugli can scarcely afford water for them, I fear. I do not think, then, that much can, or need, be done towards restoring the river above Calcutta. Reclamations opposite Calcutta have, we have been told, had a bad effect; but Mr. Vernon-Harcourt reassures us by saying that this has probably reached its maximum. The actual Port of Calcutta seems, therefore, not likely to fall off much unless conditions materially change.

What the Port Commissioners now have under their special consideration is that section of the river which extends towards the south as far as Diamond Harbour—that is to say, the river as distinguished from the estuary. In this section there have been frequent alarms, caused for the most part by temporary changes in the river bed; and there are portions which are always more or less troublesome, and in which there is no margin for deterioration. Of these the most important are the Moyapur Crossing, and the shoal which bears the name of the "James and Mary;" the latter is far the worse of the two, and is the one to which the attention of the public, as well as the engineers, has been especially directed. I think it will be more interesting to you if I try to make this vital matter clear, than if I cover more ground in a vague way.

I have already mentioned the Damuda River and its present outlet into the Hugli. Almost opposite, but a little lower down, is a projection called Fulta Point. Some six or seven miles above Fulta Point, on the same bank (that is to say, the left bank) of the Hugli is Fisherman's Point; and almost at an equal distance south is Hugli Point, which in old days was regarded at the beginning of the Hugli River, and was called Hugli River Point. The left bank has a well-marked concave bend each way from Fulta Point; that is northwards between Fulta and Fisherman's Point, and southwards between Fulta and Hugli Point. The Hugli is nearly three-quarters of a mile wide at Fisherman's Point, but broadens to about double that width about two miles above its junction with the Damuda. Exactly opposite Fulta Point it narrows again to the former width. It soon, however, broadens again, and by the time it reaches Hugli Point is over a mile wide. As it passes round Hugli Point there is a sudden turn at considerably less than a right angle to the left. Opposite Hugli Point (that is seven or eight miles south of the Damuda), the Hugli receives, almost at right angles, the river Rupnarain, which itself used to be called the Gunga or Ganges, and is believed to have been once the principal western mouth of the great river. The Rupnarain is over three-quarters of a mile broad at this junction, and much broader a little higher up. It is almost in a line with the Hugli below Hugli Point.

The Damuda and Rupnarain together, in the highest floods, are capable of bringing down rather more water than the Hugli above the Damuda can bring. So far as I can understand, the action of the Damuda on the reach of the Hugli below Fulta Point is generally beneficial; for the water brought down is carried across the river and helps to scour a channel in the concave bend below Fulta Point. The action of the Rupnarain on the part of the channel below its confluence with the Hugli appears also to be beneficial. But immediately above the confluence, and more or less in the middle of the river, lies the shoal which is known as the "James and Mary."

An account of a journey made towards the end of August, 1676, by Sir Streynsham Master, agent at Fort St. George, mentions the violent

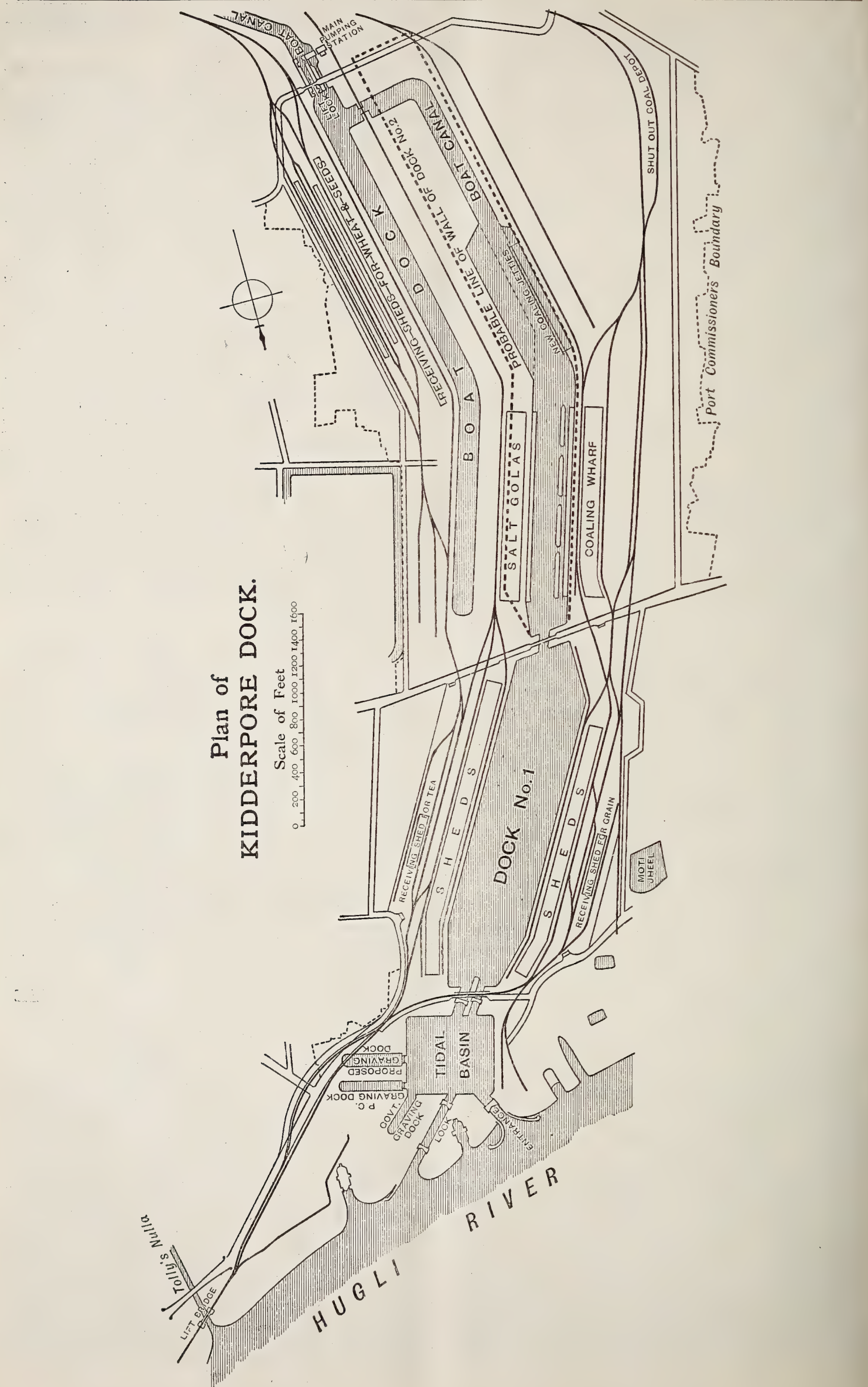
eddies at this point, but says nothing of a shoal. The earliest sailing directions, said to have been based on inquiries made in 1684, also mention the eddies but no shoal. Sir Henry Yule was, therefore, inclined to the belief that there was then no shoal. But Mr. Barlow, a very high authority, is much more cautious; he is disposed to think that, unless the conditions have much altered, the shoal existed; but he declines to dogmatise. It is worth notice that Master was travelling in a small sloop, and he expressly says that he passed this point at the top of the tide. The shoal, even if it existed, would thus have given him no trouble. At any rate, it certainly was there in 1694, for in that year the *Royal James and Mary*, a ship from the Spice Islands, was wrecked on it, and gave it her name.

The following brief account is taken from the very interesting report of Mr. Leonard, a Superintending Engineer specially deputed by the Government of Bengal to examine this shoal in 1865. The general character of the "James and Mary" is a sand about three miles long, and one-third of a mile in width, placed about the centre of the river, thus forming two channels, called the Eastern and Western Gut. Some parts of this sand are always so joined on to the bank as to reduce greatly the depth of water in both guts; but during the rains, when there is a large fresh water discharge down the river, it is so joined to the right bank as to quite close the Western Gut. Then, when the fresh water discharge of the river is very small, the sand is detached from the right bank, and so joined to the left as to close the Eastern Gut. Very often, while the changes are taking place, both channels are so bad that there is sometimes as little as six feet of water in the best of them. Mr. Leonard observes that, when one river flows into another, the consequence is that a shoal is formed above the junction and a deep channel below. In the rains, the Eastern Gut is scoured by the freshets and the ebb tide, and the Western Gut closes. In the dry season, the discharge from the Damuda is small, and the ebb tide runs, consequently, more under the right hand bank of the Hugli; then the Western Gut opens and the Eastern Gut closes. The sands forming the "James and Mary" are deposited mainly on account of the diminution of the velocity of the current of the main channel, caused by the great body of the water of the Rupnarain meeting the Hugli at nearly right angles; but the action of the Damuda water has much to do with the shape and character of the shoal.

Various suggestions have been made for evading or removing this serious cause of danger, delay, anxiety, and expense. A mode of evading it, which has been suggested, and is at first sight obvious, is that of making a short canal, $4\frac{1}{2}$ miles long, at the back of Hugli Point, leaving the river just below Fulta Creek, and entering it again near Hospital Point. This scheme, which was regarded by its parent as "comparatively small and cheap," has been examined by the chief engineer of the port, Mr. Apjohn, who finds that the canal would have to be two miles longer than the estimate, that the initial cost of a narrow width would be $89\frac{1}{2}$ lakhs of rupees, and that of a broader canal would be nearly 146 lakhs, and there would be an annual charge of 2 lakhs and sixty thousand rupees for maintenance and working. A fatal objection to it is that the delay involved in putting a ship into the canal and taking her out, and her slow progress through it, would cause her to lose a tide, and probably to arrive in Calcutta 24 hours later than by the river.

Another proposition is to have a canal from Diamond Harbour to the dock. This would cost $152\frac{1}{2}$ lakhs, or 220 lakhs according to the width, and working and maintenance would add $4\frac{1}{2}$ lakhs per annum. The south-west monsoon blows very strong up the river towards Diamond Harbour, and would (I believe) cause some difficulty at that season. But the river would probably be preferred by ships of moderate and small size, since they would have the advantage of the tide.

A third scheme proposed is to have a ship canal from the dock to the Mutlah River, which lies to the east of the Hugli, and has a different outlet to the sea. On several occasions, especially when it has been feared that the Hugli is changing for the worse, it has been suggested that recourse should be had to the Mutlah; and there are doubtless some here who remember the disastrous attempts made some 25 years ago to create Port Canning on that river, and who have seen, as I have, the melancholy unused streets and tramway, the site of the "Victoria" Dock, and the two T-headed jetties which, I am told, are yet standing. The selection of Kidderpore as the site of the Calcutta Dock was influenced by the consideration that it might some day be conveniently made to communicate with Port Canning. And I think this was a wise precaution, for it is conceivable that the Hugli may


Plan of
KIDDERPORE DOCK.
Scale of Feet
0 200 400 600 800 1000 1200 1400 1600
BOAT CANAL
MAIN PUMPING STATION
LIFT LOCK
RECEIVING SHEDS FOR WHEAT & SEEDS
DOCK No.2
LINE OF WALL OF DOCK No.2
BOAT CANAL
PROBABLE LINE OF BOAT CANAL
NEW COALING JETTIES
SHUT OUT COAL DEPOT
BOAT DOCK
SALT GOLAS
COALING WHARF
Port Commissioners Boundary
RECEIVING SHED FOR TEA
SHEDS
DOCK No.1
SHEDS
RECEIVING SHED FOR GRAIN
MOTI JHEEL
TIDAL BASIN
GRAVING DOCK
PROPOSED GRAVING DOCK
P.G.
GOVT. GRAVING DOCK
LOCK
ENTRANCE
HUGLI RIVER
Tolly's Nulla
LIFT BRIDGE

so fall off as to be no longer suitable for the larger vessels. But there are no signs of this calamity at present, and the establishment of a port on the Mutlah may perhaps be postponed till the necessity for it is more apparent. If such a port were established it would be impossible to economise much, if at all, on the Hugli, and at least the cost of lighting, surveying, buoying, and so forth (amounting, I am told, to about 2 lakhs per annum besides initial expenditure), on the Mutlah would have to be incurred by the port. The canal itself would be 32 miles long; with a bottom width of 75 feet it would cost 179 lakhs of rupees; or, if 200 feet wide, it would cost over 262 lakhs. Maintenance and working would require about $5\frac{1}{4}$ lakhs per annum.

Proposals have been made to divert the Damuda River into the Rupnarain. Perhaps the removal of the Damuda current would have the effect of permitting the down current of the Hugli to cross the river at Fulta, and pass down the Western Gut, but the Hugli would, of course, lose the benefit of the Damuda water for this space. It has also been suggested that the Rupnarain itself should be diverted into the Haldia, which enters the estuary lower down. This would obviously be open to the same objection, besides others. Both these proposals have been considered, but no recent expert has advised their adoption. Whatever other reasons there may be in opposition, those of the expense (difficult to estimate, but certain to be enormous), and the disturbance of the tract of country concerned, are final. If the Damuda could be restored to its old bed at Noasarai, doubtless the Hugli would derive much benefit through many miles of its course. I believe that this matter has been looked into, but have not seen any paper on the subject; the results, however, cannot have been encouraging; and no expert (so far as I am aware) has thought it worth while to consider it in detail. I now come to more definite plans.

The question of ameliorating the navigation of the river Hugli was considered by a civil engineer, Mr. W. A. Brooks, in a paper read in 1865 at the Royal United Service Institution. The greater part of the paper had reference to the "James and Mary" Shoals. He describes these (much in the same way as Mr. Leonard) as consisting of a maze of shoals, varying in form and depth with every change of the condition of the river as affected by the preponderating influence, at the time, of either the freshes or the strong flood tides of the south-west monsoon. He remarks that the object which should be steadily kept in mind by a engineer charged with the improvement of a navigation is to seek to lead the flood currents into the same channel which is taken by the ebbing current; and this, he says, can always be effected. The main feature of the navigation at the point in question consists, he remarks, in the ebb and flood occupying different channels, each alternately crossing at nearly the centre of the reach between Kurchi-bariah on the right bank, and Nila Khal, or crossing creek, on the left bank. Mr. Brooks discusses the feasibility of what he terms "the simple although expensive process" of straightening the navigation by boldly filling up the bight, or concave portion of the channel, abreast of the left bank of the river between Nynan and half a mile below Nurpur, thus forming a new foreshore. Such a work would have the effect of scouring away the point of land at Kurchi-bariah, and a nearly straight and safe navigation would supersede the very dangerous one which now exists. However, he rejects this plan because he considers it imperfect. It would leave untouched the tortuous navigation round Hugli Point, and would leave the strength of the flood current to set up the Rupnarain River rather than up the Hugli. He prefers the plan, which he deems simpler and probably much less expensive, of making a cut of 2,240 yards (a mile and a quarter) across the triangular neck of land on the left bank of the Hugli, the apex of which is Hugli Point, between the "James and Mary" and the Diamond reaches. The right bank of this cut would be concentric with the trend of the right bank of the river higher up between the mouth of the Damuda and Kurchibaria Point, and also with the trend lower down below the Rajnagar Point. Mr. Brooks suggested a narrow cut which, if opened out just before the great land floods, would, from the shortness of the new course, become rapidly the Hugli navigation, and in a few days be a broad and deep channel. To guard against too deep a scour the new concave bank should be faced, and possibly it might be advisable to construct a groin at Kurchibaria Point in continuation of, and concentric with, the concave curve of the right bank above that point. Detailed calculations are not given, but it is estimated that the cost would fall within £200,000.

The discussion on the paper seems to have been not very decisive, but the proposal was sufficiently plausible to obtain some support.

I do not know if it was ever laid before Government. I learn on expert authority that, even if the plan were successful, the cost would have been far in excess of the sum estimated. Mr. Brooks proposed to make the cut on the concave or shorter side, leaving the river to cut its own way on the convex side. But it is highly improbable that this would happen, for the river would try to cut on the concave side. I am told that if money were no object, and the Hugli could be forced to go as Mr. Brooks desired, there is no question that an excellent river would be the result; but these are postulates which cannot be granted. No succeeding expert has approved this plan, though it possesses the merits of ingenuity and of simplicity—at least on paper.

I have mentioned Mr. Leonard's deputation. After much enquiry and study of many river works in other countries, he submitted a valuable report, from which I have already quoted. In a preliminary paper, he suggested that an increased discharge might be obtained from the Damuda at Fulta, and his final advice was that the right bank of the Hugli should be improved at the junction, and a groin thrown out below that point. But the main feature of his scheme was the construction on the left bank of the Hugli of a mile of brushwood spur from Fulta Point, followed by a mile of training wall of burnt clay. The object of this was to throw the downward stream of the Hugli and Damuda combined into the Western Gut, so that it might alternate there with the flood tides. Mr. Leonard also laid great stress on the necessity for works protecting the mouth of the Rupnarain, which is gradually growing wider, and more in a straight line with the lower Hugli.

Sir Charles Hartley, to whom Mr. Leonard's preliminary memorandum was submitted, agreed as to bringing a greater flow from the Damuda, and advised the construction at the "James and Mary" of an "isolated work," a wall of rubble stone. The length should be estimated at 10,000 feet, but, in practice, he said, should stop considerably short of the extreme upper and lower limits of the shoal, and should only be continued thence for such lengths, and in such directions as experience might dictate. If this work were carried up to half tide level, it would not encroach on the tidal area, which he thought it very important to maintain, and would keep up a constantly good navigable channel. The work would form an artificial island, and probably the necessary scouring would be effected by the current.

There was no immediate practical result from these discussions, though they tended to increase knowledge, and prepare the way for future engineers.

In the year 1895 the condition of the Hugli suddenly became such as to cause some inconvenience and greater alarm. This was no new incident in its history, and our experts hoped and believed—with justice, as events have shown—that it would not be long before the channel would recover its condition of comparative efficiency. The mercantile community very naturally hesitated to believe that nothing could be done, and it was suggested that an engineer, who had made the amelioration of rivers his special study, should be brought out to examine the Hugli and, if possible, make recommendations for its improvement. It was thought wise to consent, and since Mr. Vernon-Harcourt's well-known eminent qualifications pointed to him as suitable for this task, he was invited to undertake it. He came to Calcutta, and whether his conclusions are accepted or not, there is perfect unanimity as to the thoroughness and minuteness of his enquiries, and (I believe) as to the soundness of his views as to history and facts. All authorities concur in acknowledging the great value of his report, and all agree with him in his objections to schemes which had already been proposed.

His own proposals cover the improvement of the river in other parts, but I have only time to bring to your notice those which refer to the "James and Mary" Reach—the one eminently dangerous and inconvenient obstacle in the way of the navigation. He considers that dredging would on occasions be useful, but that this expedient alone would be of little or no effect. He holds that Mr. Leonard was right in desiring to lead the descending current gradually from about Fulta Point towards the Western Channel (or Western Gut as it is called), so that the freshets and the flood tides should be directed into one channel. But he thinks that Mr. Leonard's proposed training works, which were to be some two miles in length, would not go low enough down to secure this object, or to make the descending current adequately scour the western side of the central shoal to provide a large enough channel for the concentrated currents. And he objects to the proposed system of spurs, as one which later experience has discarded in favour of longitudinal training walls. In

making his own suggestion, he says that, for reasons given by him, it is evident that the improvement of the "James and Mary" Reach can only be effectually accomplished by training the channels of the freshets and ebb tide, from below Fulta Point, by a gradual bend into the Western Gut. Moreover, the width of the low-water channel must not be reduced anywhere within the limits of the channel through the narrow neck at Fulta Point, in order not to impede the progress of the flood tide up the deepened channel; and, for the same reason, the training wall should be kept at as low a level as practicable, consistently with its leading the descending current into the Western Gut. In accordance with these principles Mr. Vernon-Harcourt's proposal is that a training wall, slightly over four miles in length, should be constructed from Fulta Point nearly down to the outlet of the Western Gut. Being concave towards the river it would guide the freshets along it towards the Western Gut; and, by leading them against the sandbank in mid-river, would make them enlarge the Western Gut on its eastern side by scour. The training wall should be straight towards the lower end, so as not to narrow the channel unduly; and the lower end itself should be curved outwards from the channel, so as to prevent undue scour at the extremity by the sudden release of the confined current, to facilitate the outflow of this current in a suitable direction, and to afford an ample entrance for the influx of the flood tide. The height of the wall should be fixed at low water of ordinary spring tides, as the favourable concave line of the training wall, guiding the powerful freshets, should succeed in producing a sufficient scour to clear out the channel, being aided at first by a sand-pump dredger; and the lower the wall can be kept the less will it interfere with the tidal capacity of the reach. The cost of the work is estimated on the data assumed at Rs. 20,57,000. Such is Mr. Vernon-Harcourt's design, stated very nearly in his own words.

The Chief Engineer of the port (Mr. Apjohn), and the Deputy-Conservator (Captain Petley), in a joint note prepared for the assistance of the Port Commissioners, pay a just tribute to Mr. Vernon-Harcourt's "most exhaustive and able" report, and agree in thinking that, if such a training wall were constructed, it would probably have the desired effect: but they are of opinion that, if it were successful, the erosion of the opposite bank would be seriously increased if extensive protection works were not constructed; such works would not be difficult to construct, but would add materially to the expense. If the wall were a failure, the masses of weighted brushwood of which it was composed might find their way to the crossings of the channels, with disastrous effect. They differ from him in two most important respects. First, they judge from the scour caused by the wreck of the *City of Canterbury* (lost on the 17th January, 1896) that the 21 feet estimated as the average depth below low-water of the foundation of the wall ought to be increased to at least 34 feet. Secondly, they think that in tides running at between seven and eight knots, such as would at times be encountered in this locality, the work could not be carried out, unless the crest of the wall were raised above high water, so that the portion of the wall constructed might act as a base from which to extend it further. Supporting their opinion by examples, they proceed to argue that, unless the wall were constructed in this way, it would be necessary to resort to the expedient of a pile jetty along the line of the wall. They doubt the possibility of making such a jetty in such a bottom and such currents, but estimate that, if it be possible, it would cost not less than 44 lakhs of rupees. In their opinion the cost of the whole work would amount to 145 lakhs of rupees, and they are not confident that it would be successful. Mr. Vernon-Harcourt, I believe, has not been convinced by these objections. The Port Commissioners were thus perplexed by the disagreement of their very competent advisers—on the one side an eminent expert of wide experience, on the other two officers of marked ability and unequalled knowledge of local history and conditions. It was a relief to the Commissioners—I can answer for their former Chairman—that the river, becoming more favourable, freed them from the necessity for facing the responsibility of an immediate decision.

But the old tendencies remain, and the inconveniences and risks, even when the Hugli is on its best behaviour, are serious; and in these days of keen competition, merchants and shipowners are not satisfied with things as they are, if they can be made better. Every improvement in a river means bigger ships and greater economy, so that the Commissioners, as Conservators of the Port, must always be ready to consider important suggestions with attention and respect. Such a suggestion has now come from Mr. Lindon W. Bates, an American engineer, who has been consulted regarding very important works in the Scheldt

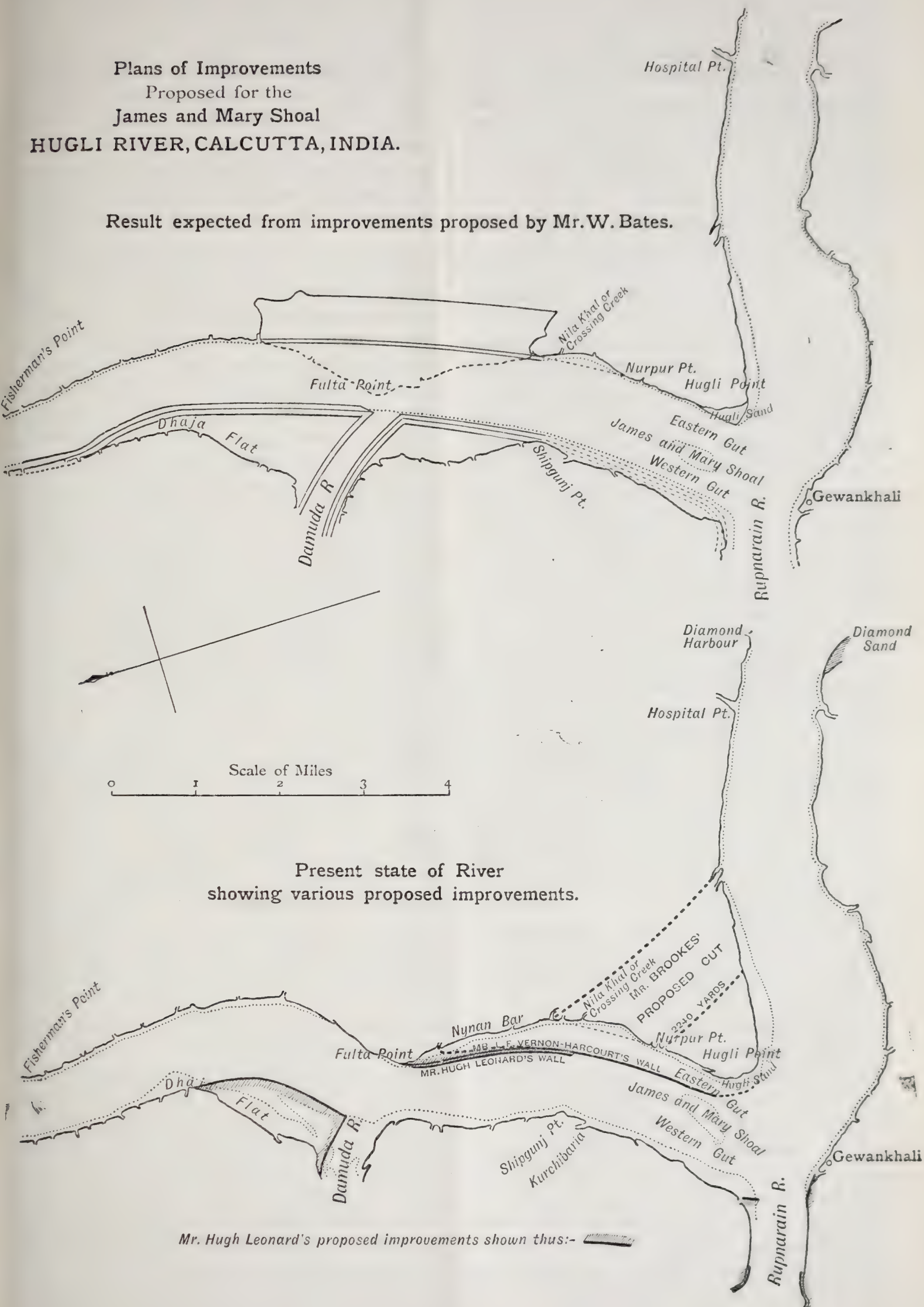
below Antwerp, and has devised and constructed two powerful dredgers for the Russian Government, to be used in the River Volga.

Mr. Bates, having had the advantage of studying the details collected by Mr. Vernon-Harcourt, lately visted Calcutta; and, though his stay there was very short, received all the help which the officers of the port could give him. He has thus considered himself in a position to make recommendations of his own for the improvement of the river generally, and especially of the "James and Mary" Shoal. He thinks the Port Commissioners well advised in not adopting Mr. Vernon-Harcourt's scheme of putting a half-tide training wall on the concave below Fulta Point. He says that nothing should be put into a river on its cutting bank; walls so placed are difficult to make and maintain, and all training works should be above highest water-mark. The true remedy is one which has only become possible by the powerful tools now available, and consists in the removal of Fulta Point; so that, in the place of the two concaves separated by Fulta Point, there should be one continuous concave from Fisherman's Point to Hugli Point. This involves the removal of a triangular piece of land, about three miles long on the base, and three-quarters of a mile from the base to the apex at Fulta Point. A rectangular tract of about double the area would have to be acquired for the deposit of the stuff excavated. An embankment would be thrown round this whole triangle, which is generally below the high-water of springs. Water would be admitted from the river, and would also be pumped up by two dredgers much larger and more powerful than those constructed for the Volga. These two dredgers would then be taken inside the embankment, and would excavate the triangle, depositing the stuff on the land taken up for the purpose. A shell would be left until the last, which would be removed at a favourable opportunity in the freshets season, so that a channel at least 600 or 700 feet wide would at once be opened under the new concave bank, and the point of the triangle would be removed as the normal width of the river was restored by training walls advancing its right bank into the flats on either side of the Damuda River; Hugli Point itself would also be slightly advanced. The effect of this, Mr. Bates says, would be to cause the deep water below the Point to move out into such a position that the deep channel under the concave bank would merge into it. The whole cost of all the improvements (of which the "James and Mary" would account for perhaps 19-20ths) is estimated, if done by the Port Commissioners themselves, at 75 lakhs of rupees, including 24 lakhs for the two dredgers, the value of which is, however, taken to be 15 lakhs at the end of the work. The price of the land to be cut away would have to be added, but this would not be large. The work would take about five years. Mr. Bates also offers to undertake the works himself as a contractor, and carry them out for £840,000; or he would execute them, receiving no payment till they were completed and a specified minimum depth and width obtained on the several bars, when a lump payment of £1,000,000 would be made to him, and success and maintenance would be guaranteed by him for twenty years under certain terms of payments and penalties, according as the bars were better or worse than the agreed minimum.

This scheme is approved by the Chief Engineer and the Deputy-Conservator; but the former officer suggests that it should be submitted to a committee of hydraulic engineers for thorough examination.

In the meantime there have been some expressions of doubt and disapproval. An anonymous writer in the *Englishman* newspaper, who has evidently much experience of the river, perhaps as a pilot, has discussed the proposal, suggesting caution, and advising that the western, rather than the eastern, channel should be assisted. In his view it is the flood-tide that does all the scouring in a tidal river; but nothing in the scheme can possibly compel a strong flood-tide to run for any time between Hugli Point and Nurpur Point; and whichever way the former is advanced, it can only create a worse eddy in the flood. The spring tides rush with great force, and, passing over the Hugli Sand, wash its loose and unstable material into the eastern channel, which presents itself at an angle of 50 degrees. There is nothing in Mr. Bates's scheme which can prevent this at a season when the flood-tides are stronger than the ebbs. It is the Rupnarain which causes all the difficulty; if this river did not exist, the flood-tides would be thrown in a regular manner across to Ninan; the Rupnarain "insists on getting a very large share of the flood's best efforts," and "the baulked tide fails, or partially fails, to keep the Western Gut open."

Mr. Vernon-Harcourt also has criticised Mr. Bates's proposals in a letter to the professional paper, *Indian Engineer*, expressed in terms


Plans of Improvements
Proposed for the
James and Mary Shoal
HUGLI RIVER, CALCUTTA, INDIA.
Result expected from improvements proposed by Mr. W. Bates.
Hospital Pt.
Fisherman's Point
Nila Khal or Crossing Creek
Nurpur Pt.
Hugli Point
Fulta Point
Hugli Sand
Eastern Gut
Dhaja Flat
James and Mary Shoal
Western Gut
Shipgunj Pt.
Damuda R.
Gewankhali
Rupnarain R.
Diamond Harbour
Diamond Sand
Hospital Pt.
Scale of Miles
0 1 2 3 4
Present state of River
showing various proposed improvements.
Fisherman's Point
Nila Khal or Crossing Creek
MR. BROOKES' PROPOSED CUT
2240 YARDS
Nynan Bar
Nurpur Pt.
Fulta Point
MR. L. F. VERNON-HARCOURT'S WALL
MR. HUGH LEONARD'S WALL
Hugli Point
Hugli Sand
Eastern Gut
Dhaja Flat
James and Mary Shoal
Western Gut
Shipgunj Pt.
Kurchibaria
Damuda R.
Gewankhali
Rupnarain R.
Mr. Hugh Leonard's proposed improvements shown thus:-

perhaps adapted to promote the vivacity of the discussion. He maintains his own position, that the great object to be aimed at for the removal of the "James and Mary" bar "is to guide the descending current and the flood-tide into a single channel, so as to put a stop to the successive opening out and silting up of each channel in turn, and to combine the present conflicting forces of freshets and flood-tide in deepening the same channel." This object will not be met by Mr. Bates's plan. It is true that the Ninan bar will permanently disappear, but in other respects conditions will be made worse; "for not only will the descending current be placed in more direct opposition to the course of the flood-tide at the lower end of the reach than at present, but the flood-tide current, which is now directed by the projection of Shipgunj Point into the ebb-tide channel below Fulta Point, would, after the dredging away of Fulta Point, by the removal of the ebb-tide channel further off from Shipgunj Point, not reach the channel along the new concave bank till about opposite Dhaja Flat, above the mouth of the Damuda. The projection of Hugli Point further into the river in the direction of Gewankhali, on the mouth of the Rupnarain, would have to be carried a considerable distance; and though such a diversion of the ebb channel might, during the freshets, lead that channel into the deep channel under the concave bank near Gewankhali, it would form an extremely awkward channel, with a sort of right-angled bend, much inferior to the present channel. On the other hand, the strong flood-tides in the latter part of the dry season, running up the river at right angles to a weak ebb, would form a bar, as at present, at the end of the Eastern Gut.

Mr. Vernon-Harcourt quotes, as an illustration of the fallacy of Mr. Bates's views, the method in which the river Weser, between Bremen and its mouth, has been successfully trained by the eminent engineer, Mr. Franzius. Since the above was written, I have been informed that Mr. Vernon-Harcourt has placed the Port Commissioners under an obligation to him by communicating his views to them direct.

I have seen the reply which Mr. Bates has sent to Mr. Vernon-Harcourt, with the request that he will publish it. After making one or two corrections in personal matters, he refrains from discussing the merits of the scheme, except before those who have to decide upon it, but says that he has shown it to the engineer, Mr. Franzius, to whose example Mr. Vernon-Harcourt has appealed, and also to the principal hydraulic authority on the Scheldt, and that both those eminent specialists have signified their approval.

It is not mine "tantas componere lites." An unlearned person might well be inclined to take refuge in the concluding words used by an engineer, Mr. Robertson, in noting on Mr. Leonard's memorandum: "The river Hugli is so large, the floods in it so great, the nature of the bottom so soft, and the quantity of silt which it brings down is so immense, that any attempt at improving even a single shoal should only be undertaken when it becomes a matter of absolute necessity." But, on the other hand, the maintenance and improvement of the navigation are of such vital importance to the Port of Calcutta and to the province of Bengal, that a scheme which appears to be mechanically practicable, and the cost of which, though large, is not prohibitive, ought not to be lightly thrown aside. I think that the Port Commissioners have blended caution with enterprise in deputing their Chief Engineer to see Mr. Bates's machines in operation, as well as to visit great works of river improvement in Europe and America. In company with two other former Port Commissioners, as well as Mr. Apjohn and Mr. Dawson, of the Bombay Public Works Department, I had lately the pleasure, by Mr. Bates's courtesy, of seeing one of his dredgers for the Volga working on the Scheldt, a few miles above Antwerp. There are two of these dredgers, precisely similar, which are intended to work side by side, but can work independently. The number of ingenious contrivances struck me with a sort of ignorant awe. I am told that these dredgers differ in two ways from the hydraulic, or suction dredgers, which have been successfully used in the Mersey. Instead of pumping the dredged material into hoppers, so that they may carry it away, they discharge it through a long pipe with flexible joints, carried each on a pontoon of its own, either to another part of the river, where it may be thrown without detriment, or to some suitable place on land. This expedient greatly increases the output. The second point is that, as they have to work in quiet waters, the silt is cut by a rotary cylindrical cutter, applied to the end of the suction-pipe and driven by a separate engine. This is said to give a great increase of power in dealing with all soils, and to make the action more steady and certain, giving the power to dredge a practically level bottom. Experience has shown that different parts wear with differing rapidity, and these can be renewed separately as required. We

saw the dredged silt removed to a distance of about 100 yards, but it can be taken four times that distance. Excavation was done at an estimated rate of 60 cubic metres per minute. The total power which can be exerted by the double dredger with its tender (or, as it may be termed, floating workshop) is 5,500 horse-power. The dredger for the Hugli would be much more powerful than these, and I may say that Mr. Apjohn has no doubt whatever that they would be able to do all the work required of them.

The objections raised to Mr. Bates's scheme are, however, not based on the ground of ineffectiveness of the proposed machinery, but on that of inappropriate river engineering, and I am disposed to think that a strong committee consisting of experts, not embarrassed by previously expressed opinions, might with great advantage be appointed to consider and advise upon this very important matter.

With regard to the estuary of the Hugli, all opinions seem to agree that no training works could be undertaken, except at a prohibitive cost, but that the very powerful dredgers now available might with advantage be used in this part. Mr. Vernon-Harcourt especially remarks that "dredging should be employed in the estuary for lowering narrow bases of abnormal height; for aiding the scour of the currents in the channel, and thereby increasing its stability as well as its depth; for facilitating changes in the course of the channel when they have become inevitable, or for opening up the portion of a channel which has become shoaled from temporary causes." For such services the two large dredges proposed by Mr. Bates for Fulta Point would (if suitable) be ready after the execution of the work suggested there. In the meantime it is satisfactory that all authorities appear to agree in holding that the channels of the estuary have not materially changed for the worse within he period for which we have any certain knowledge. So far back as the year 1844, the 12 branch pilots were consulted for the information of a committee considering the dock question. Eleven of them—men who had had the experience of 25 or 30 years—testified that there had been no deterioration. And I have just heard from the highest authority combining scientific with practical knowledge that, allowing for fluctuations from year to year, there is now in his belief a better river than there was in 1814. This is not, however, due to physical conditions only. Captain Petley—I need scarcely say that he is the authority to whom I refer—tells me that, in his opinion, some fairly deep channel nearly always existed in the estuary and entrance to the river; but, for the want of knowledge, due to imperfect vessels and instruments, many vessels in former times used to be neaped, while under the present system of surveys and constant examinations, hundreds of vessels have been saved from this inconvenience. To this I may add—and I am confident that those present who know the Port of Calcutta will concur—it is to Captain Petley's own skill and constant watchfulness that this comparatively satisfactory state of things is largely due.

I now come to the question of increased accommodation in the port. The want of docks is not one which has lately made itself felt for the first time. So far back as the year 1769 one Benjamin Lacam perceived the desirableness of securing a place where large ships could be careened and repaired without having to go to Bombay, or other distant places. He was struck with the advantages presented by Channel Creek, east of Saugor Island, and succeeded in persuading the Government to give him a grant. Before he could do much in the way of improvements it was found that he was levying tolls on the traffic from Eastern Bengal, and the grant was revoked. He fought against this decision for forty years, and induced two Parliamentary Committees to be favourable to him; but, though he received credit for "faith, zeal, and enthusiasm," as well as a more substantial compensation in the shape of a large annuity, the authorities in India were firm; the grant was not renewed; and the principal memorial now left, so far as I know, is a record some inches thick of controversies conducted with all the freedom of language which characterised the discussions of those simple times. It is just as well; for, though at least one ship (the *Charlton*, East Indiaman, of some 800 tons) successfully passed "New Harbour," the creek is now no longer navigable for large ships.

This controversy must have tended to keep the subject of improved facilities in agitation; we find that various suggestions were made before long. Committees were more than once appointed, and schemes taken into consideration. A dock was proposed in the bed of Tolly's Nullah; docks were proposed severally at Akra, between Akra and Garden Reach, at Howrah, at the site now occupied by the jetties at Diamond Harbour, and at Kidderpore. All these sites were considered with more or less care; and none were accepted,

except the last. In this instance, the formation of a Joint Stock Company was suggested. Here the matter ended, until in 1881 (the question of increased accommodation having become excessively pressing), the Government appointed a committee to consider once more the question of constructing docks at Diamond Harbour. Their report was again submitted to a very strong joint Committee of the Port Commissioners and the Chamber of Commerce, which finally recommended the adoption of Mr. W. Duff Bruce's designs for the construction at Kidderpore of an inner and an outer dock, with a graving dock, a tidal basin, two entrances, and a boat canal communicating with Tolly's Nullah. After a long and careful discussion, both of principles and of details, by the authorities concerned, and taking the advice of experts, the Secretary of State (Lord Kimberley) decided that the inner dock should remain in abeyance, and the rest of the work should go on.

Accordingly, the land necessary for the complete project was taken up, and the scheme undertaken as modified. The cost, increased to some extent by unexpected difficulties and expenses, including discount and interest on loans, was nearly 288 lakhs of rupees, which was advanced, as required, by Government to the Port Commissioners. On the 21st June, 1892, the first ship entered the dock, but the hoped for trade did not come. It is true that in the first three months 117 ships passed the dock entrance; but of them 57 were merely on their way to the Commissioners' Graving Dock, or that of the Government, and many of the remainder were merely lying up, for want of moorings in the river; the total receipts amounted to only Rs. 32,107. The Commissioners did what they could by lowering charges to allure trade to the dock, but declined to recommend to Government any compulsory measures. In the meantime, the interest on the dock loan, amounting to Rs. 11,48,000 per annum, became payable from revenue, and to meet this charge it became necessary to reimpose port dues, which had been abolished in 1884, and were now estimated to produce Rs. 4,75,000, and also to levy a special toll on all goods landed or shipped within the port; this latter was expected to bring in Rs. 8,00,000.

In this melancholy condition of affairs a Committee of the Port Commissioners was appointed to find a remedy. Neither goodwill and industry, nor mercantile experience and capacity were wanting, but with the data then before us the problem seemed insoluble, and a more lugubrious paper than our report I think I have never seen. We could not get over the facts that the steamers belonging to the regular lines, or "Liners" (as we call them), would not use the dock; and neither would consignees of imports take delivery of them there, nor had we any means of inducing the wheat and seed trade (which, as I have already shown above, is a very large item of the exports of Calcutta) to come to us. The only method which occurred to us of utilising the dock was to get the liners to discharge imports at the jetties and take in cargo at the dock; but there were objections, and the liners would not come.

The Government, recognising our difficulties, gave us a little encouragement, and the dock was kept open with a small establishment for such traffic as might present itself. By degrees the superior conveniences and appliances of the dock began to be appreciated, and in the year 1894-5 the income of the dock nearly equalled the working expenses; but the interest and the heavy municipal taxes were left as a burden on the port to be met from the port dues, the special tolls, and the general revenues.

Owing to increasing trade in Calcutta it began, soon after this, to be realised that the jetties were quite insufficient to accommodate steamers both discharging goods imported and taking in goods for export. Long delays occurred before vessels could obtain berths, and the space and appliances were altogether inadequate for the disposal of imports and exports simultaneously without confusion. At length, in concurrence with a suggestion of a Committee of the Chamber of Commerce, the Port Commissioners considered the question whether the jetties should not be confined to imports only, goods for export over the jetties being refused. This plan was extremely distasteful to exporters of fine goods, for whom it was obviously much more convenient that their wares should be put on board ship close to their own offices and warehouses.

There was much controversy: but the Port Commissioners, while regretting to be obliged to take a step which might be inconvenient to any branch of trade, regarded this as, on the whole, a less serious evil than the general loss and confusion which had begun to prevail at the jetties. They, therefore, in concurrence with a majority of the Chamber of Commerce and with the approval of the Government, decided to pass the order confining the use of the jetties to imports, though goods for export might still be received at the jetties and railed

to the dock for shipment. In the meantime berths at the dock had been used for loading ships with coal, which showed signs of becoming an important article of commerce. Other places were suggested to which coal could be taken, but all were open to serious objections. The Port Commissioners, in these circumstances, considered it necessary to make provision for dealing with this trade in addition to the general exports in the dock. They, therefore, determined to provide three special berths by deepening and widening a part of the canal which occupied a portion of the site proposed for dock No. 2. At the same time it was ascertained that Kidderpore was convenient for at least a portion of the salt trade; and the Commissioners, with the approval of Government, decided to give accommodation for this also opposite the new coal berths. Besides these arrangements other improvements were carried out, perhaps the most important of which were the extension of the railway facilities between the dock and the jetties, and the adoption of an expedient proposed by Mr. Apjohn, neither complicated nor expensive, by which the entrance lock was practically lengthened 83 feet, so as to admit the larger steamers to the dock. The result of these changes was the increase of the bulk of the imports to 89,111 tons in 1896-7 and 84,061 in 1897-8, and of the exports to 585,000 tons in 1896-7 and 1,140,464 in 1897-8. Of this last large total, 230,838 were jute; 44,327, tea; and 672,767, coal. The income, including receipts from the graving dock, had risen to Rs.11,81,731, and the working expenses (which include all charges for handling goods) to Rs.10,12,432, thus giving a balance of about one lakh and seventy thousand rupees towards meeting the municipal charges and interest, together amounting to 12 lakhs and 94,000 rupees. The income up to the end of January in the year just passed has risen to Rs.12,88,109, or more than 36 per cent. over that of the same period in the previous year. Ships of all lines now go to the dock, and many people are wondering how they could have done without it.

It will naturally be objected that what the dock has gained the jetties have lost; but the loss has really been much less than might well have been expected. The receipts at the jetties up to the end of January, 1899, are less by only two lakhs than the maximum which was attained two years ago, and actually exceed the receipts of the whole years 1893-4 and 1894-5, that is immediately before the change of policy above described was determined on. I cannot give the expenditure of the broken period mentioned above in a form which would be useful for comparison; but, as such expenditure includes handling charges, it is necessarily large, and increases as the bulk dealt with increases. The policy of the Port Commissioners has certainly had a large measure of success in bringing the dock into use; the money spent in improvements and additional facilities has brought trade there. But it is now found that more, and much more, is requisite. Large as the quantity of wheat and seeds exported through the dock has begun to be, the handling of this trade can only be maintained, not to say increased, by providing all the accommodation that those interested can reasonably demand. Again, while even so lately as 1894, it was estimated by people engaged in the coal trade, that before many years 500,000 tons would have to be dealt with, we have seen that the quantity has already risen to between two and three times that quantity. It has, therefore, again been requisite for the Commissioners to improve their three berths into four, by making their T-headed jetties into a continuous jetty, and to propose to Government the construction of two more. The graving dock, too, is now being worked to its utmost capacity, and another is urgently required. A list of these and other necessary improvements, estimated to cost 29½ lakhs of rupees, has been submitted to Government. In some respects the task of the Port Commissioners would perhaps have been easier if the Secretary of State had permitted the construction of the second dock at once, but there are many circumstances pointing the other way, and, on the whole, there seems little room for doubt that, in the long run, the caution exercised will prove to have been for the advantage of the port. It is now, however, becoming evident that the question of constructing the other dock will have to be considered seriously. The work may be said to have practically been begun by making the four coal berths and three salt berths, and there is an urgent demand for two more of the former. In some quarters it is beginning to be doubted whether the Commissioners can make adequate provision for the coal trade at Calcutta, and I see that it has been suggested that the Mutlah river should be utilised. If this suggestion were adopted it would be absolutely necessary that Port Canning should be regarded as part of the Port of Calcutta, and that the Commissioners should remain, as they now are, conservators of

the Mutlah river. I have already indicated a portion of the annual expense which would be incurred in the exercise of this function. It would also be necessary for the Government to undertake the defence of the river, and to enlarge the administrative arrangements. I doubt if the result would be economy to either the Port or the Government. Nor does the measure seem to be necessary if sufficient facilities can be given in Calcutta. An obstacle in the way has hitherto been that, in order to construct the dock, it would be necessary to close the coal and salt berths. But this the Commissioners could not possibly afford. The powerful dredger which I have already described appears now to provide the means of solving this difficulty. It is capable of doing the necessary excavation berth by berth, as it is required, without disturbing the existing trade. The method of work would, it is said, be to dredge out the site of the dock wall foundation to the required depth, and the wall would be constructed by laying in the water blocks of concrete and brickwork. This being done, the remaining spoil excavated from the dock would be thrown in behind the wall to form the wharf. The saving on the old method is estimated to be 15½ lakhs of rupees. Having regard to the importance of dredging in the port, the Port Commissioners have ordered a single dredger of Mr. Bates's design, less powerful than either of those for the Volga, to be delivered in Calcutta for an amount in sterling which I cannot exactly recall, but which will be equivalent to about 3 lakhs of rupees; this is guaranteed to excavate and deliver at a distance of 1,000 feet, one million of cubic yards of spoil per month. I may mention that the whole dredging work done by the two old-fashioned instruments now in the port during the last two years of which I have seen the reports, amounted to 482,000 (or less than half a million) cubic yards. Now that the Commissioners will have this powerful machine at their disposal, I have little doubt that they will proceed with the dock extension as being necessary to accommodate the foreign trade, and free the port eventually from the burden of the special toll. The Commissioners have the land, and indeed are now paying interest on the ten lakhs or so which it cost. If they can get the whole foreign trade to Kidderpore, the economy in management is obvious enough; since, with the exception of the cost of handling goods, it will not be much more expensive to work two docks than one. It is a signal advantage that with the new appliances no berth need be constructed till it becomes necessary. The jetties on the river bank, I believe, would always be very useful for coasting vessels and others which at present are little cared for. This improvement, it will be seen, is quite independent of the schemes for the "James and Mary"; but it has been estimated that if Government will advance the cost for both enterprises on the same terms as that of the original construction of Dock No. 1 and its appurtenances, repayment being deferred till after the existing debt has been liquidated, the whole debt would be extinguished by 1950. I regard it as most important that the existing trade of the port should not be burdened with further charges for interest on the cost of permanent improvements. The present generation has been, and still is, making large sacrifices for such improvements. To impose still heavier weights upon it would only have the effect of discouraging and embarrassing trade. But I have already exhausted you, I fear, though the topics relevant to my subject are well-nigh inexhaustible; and I must not enter into finance—a matter of which those directly interested will take good care. I will only say this: though I am the last person to suggest recklessness, the experience of the past has satisfied me that readiness to meet the requirements of the different branches of the trade, and in doing so not to shirk any reasonable expenditure, is the only policy which the Port Commissioners can adopt with any hope of ultimately freeing the port from its existing burdens.

On reference to Cesare dei Federici I find that I should have written "oil of zerzelin," instead of "zezelin." Since it appears from Colonel Temple's remarks that the word "erba" is of some interest, I transcribe the passage from Cesari dei Federici in which it occurs:—

". . . . assai panni de erba, qual è una seta che nasce nei boschi senza fatica alcuna de gli huomini, solo quando le boccole sono fatte, e sono grosse, come ogni grossa naranza, hanno pensiero d'andare a raccoglierle."

This description makes it quite clear that "erba" was tussur silk. C. C. S.

DISCUSSION.

Colonel R. C. Temple, C.I.E., said this paper had been very interesting to him. If the author would allow him to be academical rather than practical, he might make one or two remarks on that side of the subject. Taking the old trades of Calcutta, Sir

Charles Stevens quoted Federici with regard to one or two articles. The first was what he called "zezelin, a kind of seed"; this was an Italian word, not an Indian one—originally zerzolina—and it had become the Anglo-Indian word gingelly, or sesamum oil, which the natives called *til*. Sir Charles had also quoted the same author for a much more interesting word—erba, which he said was tussur silk, and that was what it really was, as he had found out for himself after spending a good many hours in trying to trace it. It turned up in the old English travellers' books as herba, but it was not to be found in any dictionary. There was an early notice of it by Alexander Hamilton, the traveller, in 1708, who called it a sort of "tough grass," and so it had remained for many years. It was also quoted by Daniel Defoe in his "Wanderings" in 1725. Yule quoted it correctly in the Diary of William Hedges (1676) as herba or tussur, and now it appeared a century earlier in Federici's account in 1565. Sir Charles also noticed a third article of trade which was perhaps more interesting than at first sight appeared, viz., jute, which was supposed to be quite modern. Yule quoted jute as being first known in 1795, but he had found an old ship's captain who said that he landed bags of jute in 1746. What interested him in these particular three words was that he had been given to edit an old manuscript, the "Log of the ship *Wake*, kept by Captain Norton," who was directed to go round the coast in 1746, his object being to get to Madras, but he did not manage it, because it had been taken possession of by the French. That gave one some idea of what travelling was in those times. He started to go from Calcutta, and when he got to Pulicat he had to turn back because Madras was no longer English. But the interesting point just now was the navigation of the ship. They had heard this evening that there was a great difficulty in old days in getting up as far as Calcutta. This ship ostensibly started from Calcutta, but, as a matter of fact, she was laden at Kalpi, much lower down, on the 15th of August, and went by the buoys of the Upper and Lower Barrebulle, and by the buoy of the fairway. This particular fairway passage had not been known for the whole of this century. It was already unusable in the days of Horsburgh, in 1809. He then went across Balasore Bay to the Black and Juggernaut Pujoda, and then stuck close to land in sounding. The interesting point here was that in those days all these captains had a book called "The Pilot," which we should call "Sailing Directions." That told them that the 15th of August was the first day they could sail safely out of the river, and at that season, if they stuck close inland, and never got out of 30 fathoms, they got a current which took them down to Madras, whether there was a fair wind or not. That was the case now, and it showed that even as far back as that the navigation of the coast was well understood. They had also heard a good deal about Fulta Point, and he had been given lately to edit a manuscript letter, dated from Fulta Point, which was of great interest to those who knew Old Calcutta. They had all heard about the Black Hole, and about that period. Now, when the English were going to be attacked, they met together and appointed a commander, Major Minchin, and as adjutant, one Captain Grant. These two worthies were amongst those who bolted from Calcutta on board a ship, and the manuscript in question purported to be a defence by Captain Grant of his conduct. It was dated from on board the *Success Galley*, 13th of July, 1756, from Fulta Point. As a matter of fact, the result of reading the letter would be to show that he was a greater poltroon really than history made him out to be. Turning to more modern times, he was glad to see Sir Charles had spoken very highly of the assistance given by the mercantile members of the Port Committee. He was for some years official President of the Rangoon Municipality, and *ex-officio* Port Commissioner for Rangoon, and, therefore, had great experience of the advice and assistance given to the officials by the mercantile members of those two bodies, and it gave him great pleasure to endorse everything Sir Charles Stevens had said on that point.

Mr. H. H. Risley, C.I.E., said Sir Charles Stevens spoke with high authority with regard to the Port of Calcutta, and hereafter when people came to look back upon the changes brought about under his management, they would say that these things happened—"Consule Planco"—when Sir Charles was Chairman. The two points which struck him as of special interest in the paper, were the beginning and the end, the beginning because it enshrined a curious bit of history—nothing less than the origin and growth of Calcutta itself. We are told how some of the native merchants began to desert Sátgáon, and came lower down, and among others were four families of Bysakhs, and one of Setts. That literally marked the manner in which the native population had grown up. Before the fort and the factory were founded, there was no native population at all. Then there gathered round the factory people who made and sold cloth; the Bysakhs being the title of the great caste of weavers. The Sett, again, was a title of a trading tribe of Rajpoots, commonly known as Marwaris, and thus the people who dealt in money, and those who dealt in cloth gathered at Calcutta. It owed its origin to European enterprise, and around it, as a centre, the native population had by degrees grouped itself. He was also interested in the reference to Tolly's Nullah, which was the holy river of the Hindu. In Sanskrit, the name was Adigunga, or "the original Ganges," and even now it was regarded with the utmost sanctity. Two years ago, when they were in difficulties about the plague, one of the arrangements which had to be made was to find a place where the people were to be burnt. It was supposed you could not burn them in the ordinary ghauts. Then it was suggested that it should be done on Tolly's Nullah, and on consulting the natives

they were all very much pleased with the idea that this ghaut should be put on the banks of Tolly's Nullah. Apart from that, it struck one as a curious contrast, such as you saw all over the East, that the two names should still survive—the European name dating from Colonel Tolly, who excavated the Adigunga—and also the ancient Sanscrit name. Sir Charles had touched on one of the groups of large problems which would have to be settled; it was proposed to straighten out the Hugli, and also to make a second dock. Assuming there were no engineering difficulties which could not be overcome, both these matters required to be exceedingly well considered. He had seen papers recently from which it appeared that there was some sort of intention to commit the Government to make the second dock, without putting as clearly as might be that that was what was really intended. There were T-headed jetties at the coal wharves, and the proposal made was that certain new jetties should be constructed, not as T-jetties, but as a solid wall, the reason being that with a solid wall you could work hydraulic machinery, and with T-headed jetties you could not. But that really meant embarking on a new dock, and it was a proposal which ought to be faced and thoroughly well considered. In considering these points, they might expect the utmost possible assistance from the Chamber of Commerce, and he would add a hope that in delivering their opinion they would give it in such a fashion that there might be no doubt as to what they meant. Even with a new dock and a straightened Hugli, all the difficulties of the trade of Calcutta would not be overcome. There would still be the difficulty of railway communication with the docks. The more work there was at the dock, the more work there would be for the railway to do. It was a very narrow space indeed, and there were mechanical and financial difficulties. As far as he remembered, the estimate was 170 lakhs. Whether it was £70,000 for straightening the Hugli, and £100,000 for the dock, or *vice versa*, did not matter, but that was an engineering estimate, and those who had to do with such things always found that there was a margin, generally a large one, and invariably on the wrong side. Therefore, the question of the sinking fund charges on the outlay was a very serious matter, and the commercial element and the Government ought to realise very distinctly what they were doing when coming to a decision, otherwise the result might be that even a heavier demand would be imposed on vessels entering the port than was already the case, and it would still be cast in their teeth that the Port of Calcutta was the dearest in the world. A very revolutionary proposal occurred to him with regard to this, which he might mention. There had been a good deal of experience on the Continent in connection with the reconstruction of cities, not ports, but still the analogy served. What had happened in Vienna, Cologne, Mayence, and other places was this—the old fortifications became useless owing to the increased range of modern artillery, and they were got rid of, and the value of the land thus made available had enabled them to finance all the magnificent improvements which took place. Now what was the use of the Fort of Calcutta at the present day? Would it not be possible to abolish the Fort, and to convert the whole of that strip into an area of useful land for commercial purposes? It would be of enormous value, and they would thus be enabled to get rid of the lift bridge, and quadruple the line of rails, and the whole thing might be financed out of the absolutely new value thus created. He recognised that this was a revolutionary proposal, which the military department would not listen to, but still it might be worth consideration. In conclusion, with regard to the plague in Calcutta, he had seen a good deal of it, the third case having occurred in the house where he was living. There was nothing more remarkable than the difference between the progress of the plague in Calcutta and in other places. Elsewhere you might say that, with hardly an exception, wherever a case had occurred it had been a centre of disease, but in Calcutta there was nothing of the sort. There had been sporadic deaths all over the town from time to time, but never anything that resembled a centre of infection. The disease had behaved so far exactly in the way that a friend of his, Dr. Douglas Cunningham, prophesied it would. He said he had no scientific reasons to go upon, but he did not believe there would ever be a bad time in Calcutta. He believed the conditions were such that for some obscure reason they were unfavourable to, and would kill the plague bacillus, and it was certainly remarkable that in the two outbreaks which had occurred the disease had behaved in exactly the way Dr. Cunningham prophesied. The trouble was not the plague, but the panic. The state of things in Calcutta in May, 1898, when a stampede of natives was going on, was most singular. Streams of people, mostly women, were making for all the ghauts on the river. If you stopped them and asked them where they were going, they said they were going home to the country, everybody was going, if they stopped they were all going to be inoculated. The one thing which at that time did more than anything to keep them in Calcutta at their work was the issue of certain blue tickets on which was printed "the bearer of this is not to be inoculated without his consent." It worked like magic, thousands asked for them, even his own servants, but still there was a very formidable exodus, the extent of which could not be exactly ascertained, but it could be gauged by one instance—the Indian Museum, one of the most popular institutions in Calcutta, which was visited by every native who came. He had statistics to show the difference in the attendance of natives at that museum for the two months, May and June, 1898, compared with the same months of 1897. In the non-panic months the total number of visitors amounted to 63,000, but in the panic months they dropped to 9,000. These figures, which were perfectly free from suspicion, inasmuch as they were taken

at a turnstile, showed the effect of a panic of that kind in paralysing trade.

Sir STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., said it was too late to continue the discussion, even had he anything to say, but should there be anyone here anxious to assist in the discussion, he would remind them that the Secretary was always glad to receive the unspoken speeches of gentlemen to be added to the discussion in the *Journal*. He only rose to say how grateful they were to Lord Elgin for the honour he had done them in attending at this the last meeting of the Session. They had had many other distinguished persons in the chair, and many interesting papers, but no paper had been more interesting than the present one, and they had had no greater honour than to have Lord Elgin in the chair.

The CHAIRMAN said he was much obliged to Sir Steuart Bayley. It had been a great pleasure to him to be present and to hear the paper. Sir Charles Stevens had shown the great grasp of the subject, as he had ventured to predict, and it was his pleasing privilege as Chairman to move a cordial vote of thanks to him.

The vote of thanks having been carried unanimously,

Sir CHARLES CECIL STEVENS, in reply, said he had long known Mr. Risley as a financial expert, in which capacity he had enjoyed the benefit of his assistance. He was not unconscious of the financial difficulties to which he had referred, but, as he had said, that was a matter which might well be left to be dealt with by those who were personally and directly interested in the matter. He had perfect confidence that they would deal adequately with it, and, therefore, he had not ventured to make any recommendations himself.

Mr. W. S. SETON-KARR writes:—I wish to send a few remarks on the great question so ably discussed in the paper of Sir C. Stevens. I have, of course, no claim to speak as an expert or Engineer, but having some practical knowledge of the vagaries and changes effected by the Ganges and its distributaries in several of the districts of Lower and Central Bengal, such as Rajshahi, Fureedpur, Jessore, Nadya, the 24 Pergunnahs, and Hugli, I feel warranted in throwing out some suggestions. In the first place, I can state that, between the years 1842 and 1869 inclusive, or my period of active service in India, I never recollect a time in which some proposal or other was not under discussion, in the Press and in official correspondence, in regard to these rivers. There was, generally, a dread that this or that channel was silting up; and there were repeated proposals for dredging, improving, or widening the channels. It has always appeared to me that the enormous volume of water caused by the melting of the snows in the hills, and the periodical heavy rains in the plains, must find its way to the ocean by some one exit or other; and that if one passage was obstructed, another, somewhere else, would be deepened or enlarged. At any rate, I do not make out that there is any indisputable evidence to prove that the obstacles to the free passage of large ships up the Hugli have increased since the beginning of this century; though fluctuations and changes must always give occasion for watchfulness and anxiety, while Engineers of great experience and ability seem to me to differ as to the precise remedy in each case. To my unscientific view it appears that in dredging and widening existing channels lies the best chance of success. The expense of canals and new short cuts would be very great, and I venture to think that we might confine ourselves to assisting Nature in her obvious efforts and in her own selected channels. I am quite aware that, by a general consensus of opinion, over the plains of the Lower Ganges the general level of the soil has been raised by the accumulation of silt and deposit within the last century, and that a similar rise has taken place in the beds of some Bengal rivers. Indeed, even at this distance of time and place, I could point to spots where the *jhil* has silted up, and the streams have lessened in volume in the last fifty years. Yet, I repeat my conviction that the periodical rainfall amounts to a volume of water not less than it was in the days of Warren Hastings, and that this downpour must find an outlet by some channel or other, into the sea. The mention of the river Bhairab, in the district of Jessore, reminds me that when I first knew that part of the country, in 1845-6, natives, advanced in age, averred that within their own knowledge, or in living memory, it was possible to get to the Ganges or one of its distributaries, by going up the Bhairab in a boat. This, both then and since, was quite impossible. Communication with the Sunderbunds below the station of Jessore was and is quite possible. As regards the Mutlah and Port Canning, I recollect that when the first venture was made some 35 years ago, it was pointed out that the transfer of heavy goods from ship to a terminus more than 20 miles distant from the town of Calcutta would, in all probability, cause the project to fail. On the whole, I should place reliance on dredging the Hugli, and in the New Docks, which seem to me a vast improvement.

Mr. MARTIN WOOD writes:—There can be nothing but praise for Sir Charles Stevens's painstaking, indeed, exhaustive history of the obscure, troublous rise of Calcutta, and the modern expansion of its port appliances. Yet when this story and description are looked at from the other side of India, and when the question of outlay from State funds comes in, a somewhat wider survey seems required than that taken in the paper itself, or in the few subsequent remarks that really touched the subject as a great

public works question of some imperial consequence. Those who, on the banks of the Hugli, regard it from the inside, are naturally impressed with the local sentiment, " here we are, and here we must remain." One must admit that it is scarcely conceivable that the immense aggregate expenditure incurred in the strenuous efforts to create a great port on a situation which, as Lord Elgin neatly implied, is one of the worst that could have been hit upon, shall not continue to be utilised, even at further expense. Those efforts, so graphically described by Sir Charles Stevens, are a record of tenacity and determination, mainly British from Job Charnock forward, to make the best of a bad job. Had Rudyard Kipling's ditty, quoted in the opening of the paper—

> "As the fungus sprouts chaotic from its bed . . .
> Chance-directed, chance-erected . . . on the silt,"

needed any matter-of-fact confirmation, that is found in this paper. So that, looking before and after, the bard, after all, has the best of the argument; thus "the popular notion of the origin of Calcutta," and of its fitness as a port for ocean-going vessels, holds the field. Though cited with quite a different object, the searching surveys and masterly judgment of Mr. Vernon-Harcourt, and other hydraulic engineers, seem to drive one to a feeling of hopelessness as to the practicability of making Calcutta an effective port for the ever-increasing bulk of modern vessels and international commerce. Very curious and interesting were the surmises, referred to in the paper, as to the rise and progress of the "James and Mary" shoal; but there the apparently irrevocable obstruction remains, and it must have been a counsel of despair when it was proposed to make an artifical island of it—though how to construct retaining walls on the silt will require a double-Dutch engineer to explain. However, adopting the spirit of Sir Charles Stevens's paper, it is forbidden for anyone to despair. Though the present Calcutta port cannot be superseded it may and must be supplemented. It needs an impartial stranger to see this for Calcutta folk cannot; and even the open-minded Bengal Civilian only looks askance in that eastern direction whence alone substantial relief can come. He shares the local sentiment that regards the Mutlah as a bugbear; but nature and physical facts must eventually overbear that short-sighted sentiment, though this derives its strength, as already intimated, from the habitual reliance of business men (many of them birds of passage) or what serves their turn for the time. But they need not shut their eyes to the eastern outlook as if the mere glance in that direction could shake the foundations of the stuccoed palaces around them, and undermine their godowns and the modern jetties on the Hugli; while, *pace* the revolutionary Mr. Risley, that historic memorial Fort William may be left intact. For the right way to grandly supplement the otherwise decaying port of Calcutta has already been entered upon. Once more the "chance-directed," the "chance-erected" Kidderpore docks have shown the way, with the canal behind them, for which Sir Charles Stevens, with his usual completeness, gives the estimates. These are details which, though big enough, need not foreclose renewed efforts to solve the problem of the Port of Calcutta—while we will consent to use as little as may be the name of "Port Canning the forsaken." The comparison, from the standpoint of harbour engineering principles, may be stated almost in a single sentence. The Mutlah is an estuary with deep water close in shore, and can be easily adapted for the largest ocean-going vessels, which cannot much longer be dragged up the Hugli—a river with its fiercely-rushing tides, now and again overborne with devastating "bores," with its ever-shifting sandbanks, and its low-lying mud-made shores. The choice will have to be accepted, sooner rather than later, if the commerce of Bengal and north-eastern India is to increase, or even maintain its present volume.

Miscellaneous.

AUTOMOBILES IN FRANCE.

An interesting report on Automobiles in France has recently been made by the United States Consul at St. Etienne. He says that not a month passes without some new company starting up, and the variety of systems offered to the public is almost beyond the limits of nomenclature. Naturally, the reason of this keen competition on the part of the different firms is the constant demand of the public to possess the new mode of locomotion, and that, in spite of the costliness of the vehicles. It is now many years ago, shortly after the Franco-Prussian war, that MM. Dion and Bouton, who built engines more or less ingeniously devised to draw carriages, endeavoured to demonstrate the possibility of using steam carriages on the roads. But these motors were independent of the vehicles. The point in consideration was not only to have the motor apparatus form a part of the carriage itself, and of the smallest compass possible, but also to find a substitute for steam. Gas was tried, but was proved inapplicable and expensive; electricity, which Consul Brunot says he doubts not will in the near future supplant every other motive power, was not sufficiently practicable. The choice fell on petroleum, which, up to the present, appears to fully answer the expectations both of the carriage builders and the public. At first, however, the smell of the oil was very disagreeable, but this inconvenience has been almost totally suppressed by most builders, and satisfaction is general. The petroleum motor is a kind of gas motor, furnished with an apparatus for mixing immediately hydro-carburets with air; this apparatus is called a "carburettor." The first patent for petroleum vehicles was taken out in January, 1884, by Gottlieb Daimler, a German engineer. A year later he considerably improved his system, and almost immediately several

great automobile constructors abroad adopted it, and among others, in France, MM. Lavassor, Peugeot, and Rossol de Lille. The superiority of petroleum motors over steam was demonstrated in 1894, in the competition organised by *Le Petit Journal*. Out of twenty-one motor carriages which ran between Paris and Rouen, fourteen were petroleum and seven steam. All the former accomplished the journey without difficulty, while only three of the latter were able to arrive at their destination. Until quite recently, automobiles were only regarded as articles of luxury, but their practicability was so apparent, and impressed the public mind so favourably, that several commercial houses have adopted them for the transport of their goods, while a large cab company in Paris is running about 500 of them for public fares. All this goes to prove the great and increasing interest taken in the new means of locomotion. There are also one or two factors which will assist us to understand why automobiles can be adopted with facility in Europe, and why the idea has been readily seized upon by the French people. It is well known that France possesses the best road system in the world. The highways are admirably kept, and are as smooth as billiard tables, that is to say, the national modern routes. Before the Second Empire, the roads ran over hill and dale, irrespective of all obstacles; but under Napoleon III., who did so much for the improvement of communication, the engineers adopted the better plan of following the course of the streams, so that the roads are almost absolutely level, and, therefore, admirably suited for automobiles. Another factor which has its importance in the subject under consideration is that there is no restrictive legislation on this method of travelling. The automobile carriages are regulated by the same laws that appertain to every other vehicle. So long as the vehicles keep to the right side of the road, do not run at breakneck speed, and have their lamps lighted at dark, they are free to come and go at will. The carriages have generally three grades of speed—slow, moderate, and quick. The petroleum used is called the essence of petroleum, with a specific gravity of 700, and costs about 4½d. per quart. Some employ naphtha; this costs one halfpenny more per quart, and the cost of running is about three farthings per mile.

General Notes.

Berne Educational Exhibition.—The Education Department has received from Berne an announcement that an Educational Exhibition will be held in that city next autumn. The authorities organising the exhibition will welcome exhibits illustrating education in this country. They are specially anxious for exhibits showing methods of physical training and the nature and organisation of school games. Communications from those willing to take part in the exhibition should be addressed direct to the Director, Schweizerische Permanente Schulausstellung, Bern, from whom further particulars can be obtained.

Electric Cabs.—The *Electrical Engineer* gives particulars of the improvements made in the London Electric Cab Company's vehicles, which are now on the road again. The electric motors have been increased in power from 2½-horse power to 3½-horse power. The motors are mounted on a hinged tray at the back of the cab, and, by means of india-rubber studs, jar on the motor and gearing is largely prevented. The driving gear is of the same general type as of the older cabs, and chain driving is still used. In order to reduce the wear on the driving tires, the brake has been made to act on the band wheel, instead of on the rubber tyre itself. Two of these band brakes are provided—one for each of the driving wheels—and in this way the life of the tires will be very largely increased. In addition to this, an electric brake is obtained by means of an additional step on the controller, which provides for five forward speeds and one reversing step in addition. The company is now generating its own current at the rate of 1d. per unit at the switchboard, as against 2¾d. per unit during the day and 4d. per unit during the night, charged by the Electric Supply Company formerly. The batteries provided are only supposed to propel a cab a distance of 32 miles—which is far less than was formerly announced—but to keep on the safe side an average run of 25 miles with the one set of accumulators is to be recognised.

The Sugar Industry of India.—A return has been presented to the House of Commons showing for the years 1882-83 to 1898-99 inclusive (1) the quantity and the value of imports of sugar into India from Germany, Austria, and Mauritius; (2) the acreage of sugar-cane cultivation in the several provinces of India; (3) the quantity of refined Indian sugar exported from Bengal and the North-West Provinces to other provinces of India and to the native States; and (4) the quantity of Indian sugar, refined and unrefined, exported to Ceylon, to the United Kingdom, and to other countries. The quantity imported from Germany steadily increased from 1889-90 until 1897-98, when it reached a total of 1,203,309 cwt., but during 11 months of 1898-99 it was only 396,352 cwt. The supply from Austria was 3,087 cwt. in 1889-90, 945,745 cwt. in 1897-98, and 921,804 cwt. in the 11 months or 1898-99. The arrivals from Mauritius have not varied very much during the above ten years, and the figures for the 11 months of 1898-99 were 1,592,636 cwt., which is more than for any previous complete year. The total acreage under sugar-cane in India has fluctuated a little from year to year, with, on the whole, a tendency to increase until 1891-92, but since that year, when it reached 3,100,147 acres, it has fallen off, the area for 1897-98, the last year given, being only 2,675,763 acres. This latter figure includes, however,

an estimate for Bengal. The exports of refined sugar from Bengal to other parts of India had fallen off a good deal up to 1896-97, the last year for which statistics are available, but those from the North-West Provinces and Oudh to other provinces have been fairly maintained since 1886-87, though they have diminished since 1893-94. The shipments of sugar, refined and raw, to over-sea countries, including Ceylon, have fallen off very much during the 17 years under review, and especially since 1889-90, In that year the export to the United Kingdom was 1,168,354 cwt., in 1897-98 it was 447,070 cwt., and for the 11 months of 1898-99 221,816 cwt.—*Times.*

German Emigration in 1898.—The Imperial German Commissioner's report upon emigration in 1898, just published, shows that the bulk of the German emigration is in the direction of the United States. In 1898, 100,978 persons emigrated from German sea ports, viz., 60,486 from Bremen, 39,882 from Hamburg, and 610 from Stettin. Of these emigrants, 17,173 were from the German Empire, viz., 8,826 *viâ* Bremen, 8,170 *viâ* Hamburg, and 177 *viâ* Stettin. The greater part—83,805—were of other nationalities, among whom 38,493 were from Austria-Hungary, 27,853 from Russia, and 14,600 from the United States. The latter were by far the greater part Americans on their way back home, who, though carried by emigrant ships, did not belong to the class of emigrants. From Roumania 855 persons came; from Denmark 276; from other European countries there were still fewer. The principal goal of all emigrants is the United States. To that country went 88,548; to British America 4,698; to the Argentine Republic 2,521; to Brazil 1,713; to Africa 1,886; to Australia 674; to Asia 302; to Chile 191, and to the West Indies 115. Emigration irom German ports has upon the whole increased a little in 1898. The gain is, however, only in the number of non-German emigrants. The United States Commercial Agent at Bamberg says that only a small number of emigrants left in 1898 (as in former years) for the German colonies in Africa, and the efforts of the Hanseatic Colonisation Association, formed in order to promote German emigration to Santa Catherina, in South Brazil, have also so far been attended with very scant success.

Oil for Laying Dust.—The *Engineer* describes some experiments in the use of oil for the laying of dust on the line of the Baltimore and Potomac Railroad between Baltimore and Washington. It appears that the oil used is of a very high fire test, and of low gravity. It is said that these experiments have been most satisfactory, especially where the tracks are ballasted with gravel. The non-existence of dust reduces the wear and tear on the rolling stock, preserves the upholstery of the carriages, besides making travel much more comfortable and enjoyable. The oil is said to sink into the ballast on the first application to a depth of 4 in.; destroys vegetation in it, and remains effective in every way for about a year. A second or third application penetrates below the cross-ties, and subsequent treatment is unnecessary unless a fresh ballasting is used. A specially constructed car for sprinkling purposes is made use of, and conne cted by a rubber hose with an ordinary tank car in which the oil is carried. The cost of oil per mile of single track is from £6 to £9, depending on point of delivery, and the quantity used is about 2,000 gallons. This is for the first application, and £1 to £1 10s. annually will be a sufficient expenditure for oil in subsequent treatment. About 1,000 miles of track in the United States have been treated in this way.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 19...Geographical, University of London, Burlington-gardens, W., 3½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Annual Meeting. Address by Sir Richard Temple.

Tuesday, June 20...SOCIETY OF ARTS, 9 p.m. Conversazione at the Natural History Museum, South Kensington.

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. A. W. Flux. "The Flag and Trade."

Photographic, 12, Hanover-square, W., 8 p.m. Mr. Redmond Barrett, "Retouching."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Hon. Walter Rothschild, "The Species of Cassowaries." 2. Mr. C. W. Andrews, "The Remains of a new Bird, *Prophaethon shrubsolei*, gen et. sp. nov., from the London Clay of Sheppey." 3. Mr. J. Y. Johnson, "The Antipatharian Corals of Madeira."

Colonial Inst., Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. Hugh C. Clifford, "Life in the Malay Peninsula: as it was and is."

Wednesday, June 21...Meteorological, 70, Victoria-street, Westminster, S.W., 4½ p.m. 1. Dr. Robert H. Scott, "Heavy Falls of Rain recorded at the Observatories connected with the Meteorological Office, 1871-98." 2. Mr. R. C. Mossman, "Average Height ef the Barometer in London." 3. Mr. Joseph Baxendell, "A New Self-Recording Anemoscope."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. Mr. Jas. Yate Johnson, "Notes on some Sponges belonging to the Clionidæ, obtained at Madeira."

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Discussion on paper by Mr. J. D. Kendall, "The Silver-Lead Deposits of the Slocan, British Columbia." 2. Mr. William Blackmore, "A New Type of Mechanical Calciner." 3. Mr. J. F. Wells, "Notes on the Occurrence of Mica in South Norway." 4. T. Graham Martyn, "Notes on an Improved Muffle Furnance for Burning Coke."

Thursday, June 22...Antiquaries, Burlington-house, W., 8½ p.m.

Friday, June 23...Physical, Chemical Society's Rooms, Burlington-house, 5 p.m.

Saturday, June 24...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 2,431. Vol. XLVII.

FRIDAY, JUNE 23, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with Sec. 40 of the Society's By-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 31ST, 1899.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1898	1,495 16 1	
Do. in hands of Secretary	28 2 3	
		1,523 18 4
,, Subscriptions	5,017 8 6	
,, Life compositions	441 0 0	
		5,458 8 6
,, Dividends and Interest		557 18 4
,, Ground Rents		660 16 2
,, Examination Fees		1,468 17 6
,, Donations to Examination Prize Fund:—		
Clothworkers' Company	18 0 0	
Skinners' Company	5 5 0	
		23 5 0
,, Conversazione, 1898 (sale of tickets)		66 15 0
,, Advertisements		659 3 7
,, Sales, &c.:—		
"Cantor" Lectures	36 9 5	
Examination Programmes	20 10 10	
Fees for use of meeting-rooms	54 3 0	
Journal	131 16 1	
"Howard" Lectures	17 0	
Reports of Technical Education Congress	4 11 5	
Reports on Acetylene Exhibition	95 6 0	
Reports of Deterioration of Paper Committee	4 11 1	
		348 4 10
		£10,767 7 3

Cr.

	£ s. d.	£ s. d.
By House:—		
Rent, Rates, and Taxes	793 17 0	
Insurance, Gas, Coal, House expenses and charges incidental to meetings	241 3 8	
Repairs and Alterations	49 16 0	
		1,084 16 8
,, Office:—		
Salaries and wages	2,091 7 6	
Stationery, Office Printing and Lithography	344 11 0	
Advertising	45 3 0	
Postage Stamps, Messengers' Fares, and Parcels	187 16 11	
		2,668 18 5
,, Library, Bookbinding, &c.		57 0 7
,, Conversazione (1898)		400 8 7
,, *Journal*, including Printing and Publishing		1,968 5 11
,, Advertisements (Agents and Printing)		298 5 4
,, Examinations		1,285 18 10
,, Medals:—		
Albert	20 9 0	
Society's	18 18 0	
		39 7 0
,, Memorial Tablets		4 6 6
,, Acetylene Exhibition		81 8 3
,, "Swiney" Prize		200 0 0
,, "Owen Jones" Prizes		4 10 0
,, Drawing Society's Prizes		9 0 0
,, "Cantor" Lectures		230 17 8
,, Juvenile Lectures		24 16 8
,, Sections:—		
Applied Art	60 0 0	
Foreign and Colonial	40 0 0	
Indian	80 7 3	
		180 7 3
,, International Congress on Technical Education		30 0 0
,, Committee on Deterioration of Paper		11 12 0
,, Committees (General Expenses)		13 13 4
,, Investment of Life Compositions for the year in Consols (£399 10 0)		441 0 0
		9,034 13 0
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1899	1,706 9 2	
Do. in hands of Secretary	26 5 1	
		1,732 14 3
		£10,767 7 3

Liabilities.

	£ s. d.	£ s. d.
To Sundry Creditors	516 1 0	
,, Examiners' Fees	607 3 0	
,, Examination Prizes and Medals	121 10 0	
,, Sections :—Applied Art, Foreign and Colonial, and Indian	150 0 0	
,, Accumulation under Trusts	341 19 4	
		1,736 13 4
,, Excess of assets over liabilities		21,257 11 2
		£22,994 4 6

Assets.

	Amount of Stock, &c. £ s. d.	Worth on 31st May, 1899. £ s. d.	£ s. d.
By Society's Accumulated Funds invested as follows :			
Consols	1,942 2 0	2,126 12 0	
Canada 4 per Cent. Stock	500 0 0	547 10 0	
South Australia 4 per Cent. Stock	500 0 0	546 5 0	
N.S. Wales $3\frac{1}{2}$ per Cent. Stock	530 10 1	575 11 0	
N.S. Wales 4 per Cent. Stock	500 0 0	595 0 0	
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217 0 0	301 12 7	
Queensland 4 per Cent. Bonds	1,500 0 0	1,605 0 0	
Natal 4 per Cent. Stock	500 0 0	595 0 0	
Ground Rents (amount invested)	10,496 2 9	10,496 2 9	
New River Co. Share (New)	100 0 0	435 0 0	
	16,785 14 10		17,823 13 4
,, Subscriptions of the year uncollected		405 6 0	
,, Arrears, estimated as recoverable		140 0 0	
			545 6 0
,, Property of the Society (Books, Pictures, &c.)			2,000 0 0
,, Advertisements on the Books, due, and in course of execution			492 10 11
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1899			1,706 9 2
,, Do. on Deposit (against interest on Trusts)			400 0 0
,, Do. in hands of Secretary			26 5 1
			£22,994 4 6

Funds held in Trust by the Society.

	£ s. d.	
Dr. Swiney's Bequest	£4,477 10 0	Ground-rents, chargeable with a sum of £200 once in five years.
"John Stock" Trust	100 0 0	Consols, chargeable with the Award of a Medal.
"Benjamin Shaw" Trust for Industrial Hygiene	133 6 8	,, ,, ,, of Interest as a Money Prize.
North London Exhibition Trust	192 2 1	,, ,, ,, ,,
"Fothergill" Trust	388 1 4	,, ,, ,, of a Medal.
J. Murray, in aid of a Building Fund	54 18 0	,,
Subscriptions to an Endowment Fund	562 2 2	,,
Dr. Aldred's Bequest	173 10 0	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	500 0 0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
Dr. Cantor's Bequest	2,450 0 0	Bombay and Baroda Railway Stock } Interest applied to the Cantor Lectures.
	2,695 11 3	Ground-rents }
"Owen Jones" Memorial Trust	423 0 0	Canada 4 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
"Mulready" Trust	105 16 0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953 0 0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Amount to cover accumulated Interest on Trust Funds	400 0 0	On Deposit with Messrs. Coutts and Co.
	£14,608 17 6	

Total of Investments &c., Standing in the Name of the Society (including Society's accumulated Funds and Trusts as above).

		£ s. d.
Ground Rents (amount of cash invested)		£17,669 4 0
Consols		3,546 2 3
Metropolitan Railway 4 per Cent. Perpetual Preference Stock		500 0 0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock		2,450 0 0
Canada 4 per Cent. Stock		923 0 0
South Australia 4 per Cent. Stock		605 16 0
New South Wales $3\frac{1}{2}$ per Cent. Stock		530 10 1
New South Wales 4 per Cent. Stock		500 0 0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock		2,170 0 0
Queensland 4 per Cent. Bonds		1,500 0 0
Natal 4 per Cent. Stock		500 0 0
New River Company Share (New)		100 0 0
Cash on Deposit with Messrs. Coutts and Co.		400 0 0
Society's Accumulated Funds	16,785 14 10	£31,394 12 4
Trust Funds held by Society	14,608 17 6	

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

B. Francis Cobb }
Owen Roberts } *Treasurers.*

Henry Trueman Wood, *Secretary.*
Society's House, Adelphi, 19th June, 1899.

Knox, Cropper, and Co., *Auditors.*

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Forty-fifth Annual General Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 28th June, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's annual *Conversazione* was held at the Natural History Museum, Cromwell-road, S.W., on Tuesday evening last, 20th inst.

The reception was held in the Central Hall of the Museum, by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman, and the following Members of the Council:—Captain W. de W. Abney, C.B., F.R.S., Mr. Francis Cobb, Major-General Sir John Donnelly, K.C.B., Sir Charles Malcolm Kennedy, K.C.M.G., C.B., Mr. James Sewell Neville, Sir Walter S. Prideaux, and Mr. W. L. Thomas.

The following portions of the Museum were open:—On the Ground Floor—the Central Hall, British Saloon, and Bird Gallery; on the First Floor—the East and West Corridors.

Promenade concerts were given by the String Band of the Royal Artillery (conductor, Cav. L. Zavertal) in the Central Hall, and by the Red Band in the Bird Gallery.

The number of visitors attending the *Conversazione* was 1,664.

EXAMINATIONS.

The results of the Examinations held at the end of last March are now ready, and an advance copy has been sent to each centre of examination.

Copies for gratuitous distribution to each candidate who attended the examination will shortly be sent to each centre. Additional copies can be obtained, price 6d. each.

The dates for the Examinations in 1900 will be Monday, Tuesday, Wednesday, and Thursday, March 26th, 27th, 28th, and 29th.

MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1898-99.

To PROF. GEORGE FORBES, F.R.S., for his paper on "Long Distance Transmission of Electric Power."

To C. H. BOTHAMLEY, F.C.S., for his paper on "Photographic Developers and Development."

To DIXON H. DAVIES, for his paper on "The Cost of Municipal Enterprise."

To JAMES SWINBURNE, for his paper on "Nernst's Electric Lamp."

To J. H. COLLINS, for his paper on "Cornish Mines and Miners."

To PHILIP DAWSON, for his paper on "Electric Traction and its Application to Suburban and Metropolitan Railways."

To WALTER HUNTER, M.Inst.C.E., for his paper on "London's Water Supply."

To SIR WILLIAM HENRY PREECE, K.C.B., F.R.S., for his paper on "Ætheric Telegraphy."

To COLONEL RICHARD CARNAC TEMPLE, C.I.E., for his paper on "The Penal System at the Andamans."

To SIR JOHN SCOTT, K.C.M.G., D.C.L., for his paper on "Judicial Reforms in Egypt in Relation to the Indian Legal System."

To ARCHIBALD LITTLE, F.R.G.S., for his paper on "The Yangtse Basin and the British Sphere."

To STEPHEN WEBB, for his paper on "Intarsia, or Inlaying."

To J. STARKIE GARDNER, F.G.S., for his paper on "The Revival of Tradesmen's Signs."

Miscellaneous.

*SCIENCE AND ENGINEERING.**

We have gathered together from all parts of the kingdom to hold our second Metropolitan Engineering Conference; and we welcome here many who, temporarily at home, pursue their work in different parts of the Empire, or in foreign countries. We represent every department of engineering practice, and we are here assembled to discuss questions of great pith and moment affecting the applications of the fundamental principle of energy to further the interests and promote the comfort, health, and happiness of mankind. Engineering does not run in one groove, nor are its votaries Chauvinistic. We endeavour to benefit every race, and we welcome in our midst every nationality. We embrace in our sphere of operations the whole world. We desire to make our home in Great George-street the Mecca of Engi-

* Opening address of the President, Sir W. H. Preece, K.C.B., F.R.S., to the Engineering Conference, Institution of Civil Engineers, June, 1899.

neering; and in furtherance of this idea, I am bold enough to suggest that, at the next Conference, the Council should take measures to secure the presence of some of our members, delegated specially to represent Engineering in our Empire beyond the seas.

This Conference is not international, in the sense of that held at Chicago in 1893, or of that which I understand is contemplated in the year 1901 in Glasgow, in connection with the Exhibition which is to be held there, but it may well be Imperial. In whatever quarter of the globe we find ourselves, membership of this Institution has become a password; and the invariable support accorded to the Institution by its members in India and the Colonies, suggests the desirability of uniting them in a definite and formal manner with our proceedings on such occasions as this.

Conferences facilitate intercommunication among our members, and, by bringing us more into personal and social relations with one another, promote harmony, allay jealousy, and secure progress. Our weekly ordinary meetings are especially convenient for those who live in London; and the audiences are generally restricted to those occupied in the special branch of engineering under discussion at the moment; but these Conferences, in association with our annual *conversazione* and by combination with well-arranged excursions and visits to works, tempt many to come to Westminster who are rarely seen there, and facilitate the interchange of ideas between all the departments of our many-sided profession.

They disseminate knowledge by exciting discussion and extracting opinions from those who have acquired them from the only true master—experience—in every quarter of the world. Our weekly meetings receive and discuss papers selected from those submitted for approval, often of the character of probational essays. They open to the young and rising engineer a means of securing the attention and the support of the *patres conscripti* of his profession; but the discussions set in operation in these Conferences are based on short papers prepared for the purpose by those who have been selected as masters of their particular subjects, and invited by the Council to lay the foundation of our talks.

After very mature consideration the Council came to the conclusion that the objects of our gathering would be best secured by meeting biennially. The reasons that led to this conclusion are financial and administrative. If ever we secure another building—an event by no means improbable and not perhaps very distant, for the whole of this side of Great George-street has been absorbed by the new design for Government offices—I venture to hope that we shall realise the dream of Sir John Wolfe Barry, and have a hall large enough to hold our annual dinner and to receive the whole of our members and their friends in one evening at our *conversazione*—a hall that will vie in splendour with those of the Ancient Guilds of the City of London. No Guild and no Merchant Venturers' Society ever compared in numbers and universality of operations with this Institution of ours—the home of an association that embraces every clime and knits together by physical agencies the whole world into one connected whole. Each morning's *Times* is the daily journal of the world; we learn by our work what took place yesterday everywhere.

Now we have to give up our own building to the *conversaziones*, and to throw ourselves upon the courtesy of our friends and neighbours for accommodation for the meetings of our various sections. The Mechanical Engineers have spontaneously offered us their new home, and there the sections dealing with machinery and electricity will meet. The Surveyors' Institution—before even their own formal occupation of the building—have given us the use of their meeting and council-rooms, where the sections dealing with railways, harbours, mines, and metallurgy will assemble. The Middlesex County Council have allotted to us their council-chamber and committee-room, where those interested in docks, canals, waterworks, sewerage, gasworks, and shipbuilding will foregather and discuss.

The programme shows a plethora of important subjects for discussion. The visits to works will, we hope, provide objects of interest and instruction to every visitor. Their popularity is shown by the applications which have been received from over 1,000 members to take part in them, and on the first day nearly 500 claims had to be submitted to ballot—one-half of which, I am very glad to say, came from our members in the provinces. We are deeply indebted to those liberal and hospitable persons who have so kindly undertaken to meet our wishes in this essential feature of the Conference.

We found it inconvenient and unpractical to print and circulate the proceedings of our first Conference. We already receive four bulky volumes every year, and old members like myself find it necessary periodically to increase the dimensions of our libraries, and would rather experience a diminution than an increase in the number of our publications. The proceedings of the Conference are equivalent to one-and-a-half times the bulk of our annual ordinary meetings, and comprise three times the number of subjects ordinarily discussed in an institution Session. The proceedings are thrown open to the Press, and we hope that the enterprise of those admirable technical papers, that form such a credit to our industries, and such a benefit to our profession, will, by the completeness of their reports and the rapidity of their issue, render full publication on our part unnecessary.

The growth of engineering is illustrated, not only by the increasing number of affiiliated institutions, societies, and members, but by the new fields of application which the advancement of knowledge and the progress of civilisation are opening up, At the present moment, in ten distinct associations, more or less intimately associated with our parent institution, there are some 22,700 paying members. *Science*, a

much abused term, is the systematised collection of the facts and laws of nature, and *Engineering* is their practical application to the use and convenience of man. There is a great tendency to put the cart before the horse; science has followed, it has not led engineering. It is their intimate association which is the foundation of all industrial progress. The war of the microbes, the latest development of biology, is a consequence of sanitary requirements. Our knowledge of the diffusion of molecules and the solution of solids have sprung from the investigation into the mechanical properties and constitution of iron and its alloys, and the disturbances of the æther are becoming familiar through the practice of the so-called wireless telegraphy. Facts are derived from accident, observation, or practice; laws are the result of research. Engineers have always appreciated science up to the hilt, but they wish that its special votaries were less dogmatic and more modest.

The fathers of our profession, whose names you see emblazoned on our walls—Smeaton, Cort, Watt, Telford, Stephenson—acquired their science by their own researches when professors were largely teaching nonsense, and text-books were full of errors. We, however, acknowledge our indebtedness to pure science by giving the place of honour over this chair to Newton; and by adding the name of the most accomplished experimenter of the age, and the most modest but clearest expounder of his own great discoveries—Faraday. I had the great satisfaction last Friday to present an illuminated address to the Vice-Chancellor of the University of Cambridge from this Institution, congratulating our honorary member, Sir George Gabriel Stokes, on attaining the jubilee of his professorship—a pure scientific worthy, ranking with those two great masters who have established and taught the principles that we practise. Of the three men who have been raised by our Sovereign to the peerage for their scientific attainments, we claim two—Kelvin and Armstrong on our roll — while Lister, who belongs to the nation, is also an honorary member of our Institution.

We are proud to enrol also among this class of member another peer, Lord Rayleigh, who, if he had not attained that rank by heredity, would certainly have earned it by his grand scientific work—work so accurate and so reliable that it has secured the faith of the British electrician.

The practice of the engineer as the great civiliser has been well eulogised by our distinguished honorary member, Lord Salisbury. The engineer not only immediately follows the military conqueror, but he sometimes even precedes the civil pioneer. Mr. Cecil Rhodes is opening up Africa by the "wonder-working wire." In a few months there will be an unbroken line of telegraph from Cape Town to Lake Tanganyika. Peace and goodwill are messages thus distributed without fire, blood, or famine.

Before dismissing you to your different sections, to discuss the various questions allotted to you, I venture to allude to some questions that cannot well be discussed in public, but which may form the subject of conversation among us.

The Lord Chief Justice's Bill for the suppression of illicit commissions is one welcomed by every member of this Institution, and it is most gratifying to find that no suspicion of improper practice has been adduced against our profession. We do, however, hear at times of a dangerous border-ground between consultation work and contracting, which is a pitfall to be avoided and to be surrounded by danger-signals. Again, occasionally, and fortunately rarely, we find the diploma of the Institution converted into an advertisement; this the Council strenuously protests against in the best interests of the entire body.

The examination system introduced just at the epoch of our first Conference, has proved a most unqualified success, and it has been welcomed by none more than by those who are subjected to its troubles. During the last Session, 107 candidates passed the Associate Membership examination, in addition to 31 who qualified by passing exempting examinations elsewhere, and 65 who satisfied the conditions of election by theses. Further, 53 passed the Institution examination for Studentship, whilst 167 qualified in that respect by passing various recognised examinations. Thus we added 423 new names to our roll—all of whom satisfied the examination standards. The Council feel that the system of examination has enhanced the intrinsic value of the diploma of the Institution, and that it has added materially to the dignity and responsibility of the profession. This diploma has become so valuable and so necessary to the practising engineer, that occasionally would-be practitioners improperly assume the title of member or associate. Fortunately criticism is too wide-awake, and the public interest too well served by all who are jealous for the prestige of their profession, to permit deceptions of this kind to escape speedy detection. The position of engineering has rendered it necessary for all new Universities—and especially for the Imperial University of London—to form a faculty of engineering, but the Council of this Institution has deprecated the idea of conferring degrees in engineering. Every engineer must acquire a knowledge of the scientific principles and the mental tools that form the bases and aid the operations of his profession, but he can be an engineer only by becoming an expert in its practice. Examination can test the former qualification alone, and this is what we have introduced. Practical training is not a matter amenable to examination. Hence we consider that degrees in science are quite sufficient to signify the successful completion of a University career, which should be strictly scientific; and that the diploma of the Institution should be the criterion of that professional qualification, which is the result of practice alone. And here may I mention that there is a tendency observable to avoid the condition that those admitted into our junior ranks shall be persons who are or have been *bonâ-fide* pupils of

corporate members of the Institution. Further, no one can be said to be regularly educated as a civil engineer unless he has passed through the ordeal of the training to be acquired in the workshop and the drawing office. It would be well, for the comfort of the Council, if those who rather lightly, and sometimes thoughtlessly, sign forms for election, would first inquire if the conditions printed on the back of every form were properly complied with.

Let us sincerely hope that this Conference of 1899 ill be as successful, as pleasant, and as fruitful as that which took place in May, 1897.

DR. GEORGE SWINEY.

The following notes on Dr. George Swiney appeared some months ago in the *St. Pancras Guardian.* As little is known about this remarkable but eccentric character, to whom the Society is indebted for the bequest of the Swiney Cup, it has been thought well to reproduce them for the benefit of readers of the *Journal*:—

In the burial ground in Pratt-street there is a marble slab, enclosed in a frame of Portland stone, upon which the following inscription may, with some difficulty, be read—

HIC JACET
GEORGIUS SWINAEUS, MED. DOCT.
ANGLUS, SCOTUS, ET HIBERNICUS.
VIXIT SIMPLICITER
LUBENS OBIIT
12 KAL. FEB. MDCCCXLIV
ANNO ÆTATIS SUÆ, L.

This stone marks the last resting place of Dr. George Swiney, a somewhat remarkable man, of eccentric habits, long resident in the parish. But for the fact that he left a sum of £10,000 to found a prize for an essay on jurisprudence, and for a course of lectures on geology, his name would have been forgotten long ago, though his extraordinary funeral made a deep impression on the inhabitants of the neighbourhood, and there are perhaps some still living who were present on the occasion. He lived for a time in Sidmouth-street, Gray's-inn-road, his will, dated May 7th, 1831, having been made there. Subsequently he removed to No. 9, Arlington-road, or Grove-street as it was then called, where he died on the 21st of January, 1844. The following account of his death and funeral appeared in the *Illustrated London News* of February 3rd, 1844, where his portrait is also given:—

"This eccentric person died under very extraordinary circumstances on Sunday week [Jan. 21st, 1844] at No. 9, Grove-street, Camden Town, where he had resided for 15 years. Strange stories are related of his birth, though he was acknowledged to be the son of the late Admiral Swiney. He was a relative of the great chemist, the late Sir Humphry Davy. His age was about 50, and not having shaved for the last two years, 'his beard descending swept his aged breast.' He lived in almost complete seclusion, his house having but another inmate, a female, his housekeeper. He went abroad not more than four or five times a year. On Sunday morning becoming nearly insensible, his housekeeper called in Mr. Knaggs, surgeon, of High-street, who, having succeeded in rallying deceased a little, prescribed for him, but he would not take the medicine, and died shortly afterwards.

"The statement in the newspapers, that he died of voluntary starvation, is incorrect; his disease was of the heart, and to such an extent that the medical men present at the post mortem examination were surprised that he could have so long survived.

"Neither was Dr. Swiney of miserly habits, as has been related; he lived in a respectable street, and his house had every appearance of decent and cleanly comfort, without ostentation. His eccentricity bordered on insanity; so that his will is likely to become the cause of immediate litigation.

"Dr. Swiney died possessed of considerable property. He has willed £5,000 to the trustees of the British Museum for the establishment of a lectureship on geology, and a similar sum to the Society of Arts, out of which the first freeholder, whether in England, Ireland, or Scotland, that shall re-claim and bring into cultivation the largest amount of waste land is to receive one hundred guineas, to be presented in a goblet of equal value. This prize gift is to be renewed quinquennially. The testator has appointed five executors, gentlemen of high eminence in literature, art and science, to carry out his last requests.

"The provisions for Dr. Swiney's funeral were very eccentric. He was buried, according to his desire, on Monday last (January 29), in the cemetery of St. Martin's, Pratt-street. From the residence of the deceased to the burial ground, a distance of upwards of a quarter of a mile, the number of persons congregated to witness the funeral procession was so great that a large body of police of the S division, under Mr. Superintendent Carter and Inspector Aggs, were obliged to be present to keep anything like order. By the will three girls were to be chosen as mourners by the chief executor, and to each of them was bequeathed a legacy of £20, besides a similar amount to buy dresses for the three. About a quarter before two the funeral cortége made its appearance, and agreeably to the will of the deceased the coffin was covered with yellow cloth, studded with white nails. On getting into the street a yellow velvet pall, edged with white silk, was thrown over it. Immediately after the coffin came the three young girls, the eldest about 14 years, and the other two about 12 years of age. They were habited in white (according to the will), with violet coloured cloaks. Their head-dress consisted of straw bonnets, trimmed with white satin ribbon. The dresses had a most singular appearance, the wearers appearing more like a party proceeding to a wedding than mourners at a funeral. After these came the mutes, and then the real mourners, habited, not in yellow cloaks, as previously announced, but in the usual mourning habit. In this

order the calvacade proceeded to the burial ground, the crowd being so dense that it was with the greatest difficulty it could proceed, police-officers going first to clear the way. On reaching the ground there was hissing and hooting. The service appointed for the burial of the dead was read in a very impressive manner by the Rev. Mr. Chaplin, the officiating minister, partly in the chapel and the remainder over the grave. At the conclusion of the ceremony, despite the efforts of the police, the mass of people round the chapel was so great that the mourners were compelled to return in hired cabs to the late residence of the deceased. The mourners, of whom Dr. Cox was the chief, consisted of the executors and other friends of the deceased."

The conditions of the bequest of £5,000 to the Society of Arts were varied by a codicil, of the existence of which the writer of the above account was no doubt unaware, and a sum of one hundred pounds contained in a silver goblet of the same value is awarded every five years to the author of the best published work on jurisprudence.

The cup was executed from a design by Maclise, and although premiums were offered for a new design some years ago, none of the drawings sent in were considered satisfactory, and Maclise's design is still adhered to. Dr. Swiney left £100 to the poor of the parish in which he might die, a gold ring to the clergyman who should read the burial service at his funeral, and £50 for a slab of white marble to be placed for his grave. As I have already implied, the stone is much decayed, and the inscription might be re-cut. Perhaps the trustees under the Doctor's will, if they happen to see this, will take my suggestion into consideration.

AN OLD INHABITANT.

It may be added that some few years ago Dr. Swiney's monument was repaired at the cost of the Society of Arts. The slight repairs which were all that it was thought judicious to attempt at the time, have not sufficed to arrest the decay of the stone, and it is now intended to replace the old stone with a new one in facsimile. The attempt to preserve the old one had to be abandoned as hopeless.

ACETYLENE.

At the last meeting of the Royal Photographic Society, Professor Vivian B. Lewes read a paper on "Acetylene," which is reprinted in abstract as follows by the *British Journal of Photography.*

Dealing first with the history of acetylene gas, he said that in 1836 Edmund Davy, nephew of Sir Humphry Davy, read a paper before the Dublin Royal Society, in which he stated that, in the course of some experiments in which he distilled tartrate of potash, he obtained a residue which, when thrown into water, evolved a gas, that gas proving on analysis to be bicarburet of hydrogen, and he went on to point out its properties, and concluded his paper by showing the marvellous illuminating power of the gas, and prognosticating that it would some day play a very importaat part in connection with lighting. On reading Davy's paper, it was evident that very little advance had really been made since its date with regard to acetylene, and the facts which he put forward formed as good an epitome of the characteristics and properties of acetylene as could be compiled to-day. After Davy's time, many experiments were made, and in 1859 Berthelot commenced some researches which led to the discovery, in 1862, that acetylene could be built up from its constituents. This was followed by the discovery by Wohler, a great German chemist, that calcium carbide could be made in the electric furnace, and that it was decomposed by water with the evolution of acetylene gas. It was not, however, until 1892 that these experiments were put upon a commercial basis, when a Canadian experimentalist, named Wilson, found, quite by chance, that calcic carbide could be made directly from lime and charcoal in the electric furnace, the same result being arrived at a few months later by the celebrated French scientist Moissan as a step in some of the most beautiful researches ever made. At that time the amount of electricity necessary to make a pound of carbide was very high, but subsequent improvements had rendered it possible to make one ton per year with one electrical horse-power.

Professor Lewes next described the ingot process of making calcic carbide, in use in England and America, and the running process by which arrangements are now being made for the production of about 30,000 tons per annum on the Continent. He remarked that many people thought that if the carbide had a very fine crystalline surface it was perfectly pure, and that if it appeared like grey pig-iron it was impure, but he said that these differences were entirely dependent upon the manner in which it was cooled, and that the latter was often more satisfactory in use than the former.

With regard to the precautions necessary in the storage of carbide, and which were sometimes thought to be vexatious, he said they were not unnecessary, and that in almost every country in the world where they were not insisted upon the history of acetylene had been marked by a considerable number of accidents.

Turning to the subject of generators, the lecturer first showed the method which he described before the Society of Arts in 1895, the calcic carbide being placed in a perforated zinc cage, and plunged into a cylinder filled with water, and the resulting gas being received in a floating bell; and he then classified and described the other methods which have been adopted for the generation of the gas, laying particular stress upon the importance of obviating undue heating in the generator as essential to the avoidance of danger.

The following method was given for ascertaining whether a generator was satisfactory:—Put a small piece of carbide into water, and examine the residue;

if the residue is white, or nearly white, the carbide is of good quality; then use some of the same carbide in the generator, and if, after the generation of acetylene is finished, the residual lime is white, there is no fault to find with the generator; but, if the residue is snuff-coloured, the temperature evolved by the decomposition of the calcic carbide was too high, and the generator is not a good one.

After discussing the various forms of burners suitable for acetylene gas, the Professor alluded to its richness in actinic properties, and its consequent value for photographic purposes, and said its cost would compare most favourably with that of other methods of artificial lighting, both for studio work and for printing.

He concluded by performing a pretty experiment to show that, when a light is applied to acetylene, it burns with a luminous and intensely smoky flame, and that, when a mixture of one volume of acetylene with one volume of air is ignited in a cylinder, a dull red flame runs down the cylinder, leaving behind a mass of soot, and throwing out a dense black smoke.

ELECTRIC RAILWAY CONSTRUCTION IN GERMANY.

Of the most important German cities, Aix La Chapelle, Brunswick, Chemnitz, Dresden, Hamburg, Hanover, Leipzig, Munich, and Stetten have almost completely abandoned horse cars and are supplied by electric roads. In the cities of Berlin, Breslau, Cassel, Cologne, Frankfort-on-the-Main, Düsseldorf, Barmen, Elberfeld, Königsberg (East Prussia), and other places, horse lines are being converted into electric roads, and most of these have suburban electric roads completed. According to the United States Consul at Düsseldorf a large number of electric lines are being constructed in the country districts about Aix la Chapelle, Bochum, Gelsenkirchen, Düsseldorf, Vohwinkel, Elberfeld, Barmen, Elbthal, Essen, Krais, Hoerde, Reisengebirge, Waldenburg (Silesia), Witten-Ruhr, and in the mining districts of the Saar (southern Rheinland), and in Upper Silesia. In thirty-five cities and districts, not mentioned in the above lists, electric roads were in the course of construction on 1st September last, in nine of which the roads were completed and put into operation before the close of the year; so that at the beginning of the year 1899 there were 77 cities and districts in the empire supplied with electric roads. In 35 of these places extensions were being made to the lines in operation on the 1st September, 1898, some of which were completed before the 1st of January. From a return which has been prepared on the subject it appears that there were on the 1st September last 888 miles of electric roads as compared with 595 miles at the corresponding date in 1897. There were in September last 3,190 motor cars as compared with 2,255 in 1897. Adding the roads put in operation since the 1st January, 1899, it is estimated that there are now 930 miles of electric roads, with a total of 1,300 miles of tracks in Germany. From the city of Düsseldorf there are now four suburban electric lines completed. From Düsseldorf to Crefeld about 12 miles, from Düsseldorf to Rattigen about 8 miles, from Düsseldorf to Benrath about 6 miles, and from Düsseldorf to Kaiserwerth about 5 miles.

CARBONS IN BRAZIL.

The State of Bahia is said to be the sole seat of the carbon industry. The carbons have been found for years but there has been no market until the commencement of the present decade, when on account of their hardness they were sought by makers of so-called diamond drills. As the demand grew greater the supply decreased and prices rose. The region in which they are found is in the interior of the State and is reached only after a long and tiresome journey. It is necessary to go by boat from Bahia to St. Felix and then by rail to Bandeira de Mello. This is the edge of the diamond region and carbons are always found near diamonds. The United States Consul at Bahia says that the most productive region is further up the Paragassu river, and to reach it it is necessary to go overland by mule, following a rough and hilly pack trail for a couple of days. It is thought that diamonds and carbons are found all through this section, but on account of the rude methods of mining only the bed of the Paragassu and its tributary the San Antonio, and the side of a range of mountains called Serra das Lavras Diamantinas are worked. The carbons are found in a kind of gravel called *cascalho*, and this occurs in the river bed beneath the silt and on top of a stratum of clay; in the mountains beneath a stratum of rock and above the same stratum of clay, and in the surrounding country beneath several strata of earth. To obtain those in the river bed a place of not more than twenty feet in depth and where the current is not rapid is selected. A long pole is then planted there, and naked native divers go down this pole taking along with them a sack kept open with a ring. They first scrape away the silt and then proceed to fill the sack with the underlying gravel, removing all the gravel down to the clay. As soon as the sack is full the man above in one of the native canoes is signalled to. The bag is raised to the surface with the aid of the diver below, taken to the shore, and placed at a sufficient distance to prevent its being washed away by any sudden rise in the river. This operation is repeated day by day for the six months of the dry season. At the commencement of the rainy season when diving has to be suspended on account of the strong current and great depth of the river, the gravel is washed and examined for carbons and diamonds. The divers are very skilful and many of them can remain below for a minute at a time, there are some who stay as long as a minute and a half. The gravel becomes partly recovered by silt while they are at the surface, thus causing extra work, which would be

avoided by more modern methods. Places where there is greater depth of river cannot be worked at all. The other method of mining consists in drilling through the rock in the mountain side, and by a series of tunnels removing the diamond and carbon-bearing gravel. It is piled up in the dry season and washed during the rainy season by conveying the water down the mountain side in sluices. The greater part of the carbons is found in the mountains because they are more accessible there than at the river bottom. No mining of any importance is attempted elsewhere than above stated, except along the river bank, and little is done there because the water runs in as soon as the carbon-bearing gravel is reached, and with their rude methods the natives cannot remove it fast enough. The reason why no mining is attempted in other places is on account of the lack of water to wash the gravel after it has been raised; the idea has apparently never occurred to those engaged in this industry to use modern mining machinery, or if it did they have not the capital to invest. Carbons are found in all sizes; a very large one was picked up in 1894 on a road where the gravel formation was exposed, and was sold in Paris for 100,000 francs (£4,000). The most valuable ones are those weighing from one to three carats; the larger ones have to be broken, and there is always great loss as they have no line of fracture. Thus the largest carbon found, after being broken into saleable pieces, brought considerably less than £4,000, the cost price. About two years ago there was a local combination to keep up prices, but the chief promoter failed and there has since been no attempt to combine. The price that now prevails is due entirely to the great demand, small supply, and the laborious method of mining. The small supply is due to the crude methods. Frequently a couple of workers will obtain only three or four carbons as a result of their six months' work, and for these they demand and receive a good price. The large export dealers have their business at Bahia and agents in the mining regions, but as the miners keep themselves posted as to the market price the dealers are little more than commission houses.

AGRICULTURAL PRODUCTS OF TOGOLAND.

The principal products of Togoland (a German colony in West Africa, between the British gold coast possessions and Dahomey) are oil palms, coco palms, india-rubber, and coffee. The most important, from the European point of view, is the kola nut, to the cultivation of which great attention is being paid. Regulations have been issued to prevent the wanton destruction of india-rubber trees, and the dealers receive licenses from the Government. Only natives are allowed to collect this product, strangers being forbidden to ply the trade without a special license, which costs £50 a year. It is not allowed to give natives an advance on the year's yield. According to a recent report by the Second Secretaries of H.M. Embassy in Berlin, the cultivation of the oil palm has not yet been undertaken by Europeans, and remains in the hands of the natives. Good building wood is supplied by the following trees:—*Chlorophora excelsa*, *borassus flabelliformis*, and *eryodendron anfractuosum*. There are six coffee plantations, the number of trees varying from 30 to 3,000. The yield is given as 4,300 kilogrommes (9,479 lbs.). Coco nuts last year were grown in five plantations, varying from 33 to 1,000 in each, and the yield given was 10,000 nuts. New undertakings are in view. In the mountains, five days journey from the coast, the natives are growing coffee with success, and plantations on a large scale, with European capital, will shortly be commenced. The india-rubber tree (*manihot glaziovii*) is grown in the coffee and coco nut plantations. It does fairly well, but suffers from a blight (*Loranthocos*) which does much damage. Cassave (tapioca), yams, maize, and earth nuts are also cultivated with success. An experimental plantation is carried on at Sebbe. It has been found that the trees which do best are mangoes, eucalyptus, banana, bixa orellana, oranges, and coffee. Mulberry trees do well in the rainy season, but three-quarters of them die in the dry season. A new garden is being started at Lome, where native gardeners are being trained. Coffee, manihot, *kikxia africana*, *inophyllum*, &c., are being raised from seed. The following annuals are being grown:—*Ricinus*, *sesamum indicum*, oil plants, maize, *andropogon*, and *corchorus capsularis*.

THE FISHERIES OF NEW SOUTH WALES.

There are stated to be no less than 60 different families of fish, comprising 348 species, frequenting the waters of New South Wales. The edible fish comprise 105 different species, and among the best known may be mentioned the following. The schnapper (*Pagrus unicolor*), the most valuable of all Australian fishes, is found along the whole extent of the coast, and is very abundant. It is a deep-water fish, found generally near rocky points or reefs running out into the sea. The schnappers "school," as it is termed, during the summer months, and are then most plentiful. The young fish, known as red bream, frequent the harbours and estuaries of the coast, but are never found in shallow water. The schnapper is caught by the hook, which it takes freely, as it will attack almost any bait. It sometimes attains a very large size, weighing as much as 30 lbs. The fish cures well, and is said to be equal to the finest cod, and is in every respect superior to ling. The nannigai is a deep-water fish, caught with the hook, and ranks high in public estimation as an edible fish. The supply, according to the Government Statistician of New South Wales, is not large, as the fish is not especially sought after, being chiefly obtained by fishermen in search of schnapper. The nannigai is

scientifically interesting as one of the oldest forms of bony fishes now surviving. The black rock-cod is considered one of the best of Australian fish, and is also a deep-water fish, never captured by the net. It grows to a large size, specimens from 35 lbs. to 40 lbs. being not uncommon, whilst fish weighing over 100 lbs. are met with in the markets. It is found more abundantly in the warmer waters of the north of the colony, where, as a rule, it attains larger proportions than to the southward of Sydney. In the vicinity of the islands lying off the New South Wales coast—the Seal Rocks, Solitaries, Elizabeth Reef, and Lord Howe Island—the black rock-cod may be taken in almost any quantity, and of the largest size. A fish of great size and beauty, known in Australia as the salmon, is found off the coast in prodigious quantities. It has no affinity whatever to the true salmon, and is inferior as an article of food. The flathead, a fine fish, of which there are several varieties, is captured both by the hook and net. It is of excellent quality, and ranks high among New South Wales fishes. There are four species of whiting found in New South Wales waters. The common sand whiting and the trumpeter whiting are both very abundant, but the other two species are more rare. The sand whiting is, perhaps, the fish most in demand in the metropolitan markets, where it is to be obtained all the year round. The jew-fish is the largest edible fish found on the New South Wales coast, attaining sometimes a length of 5 ft. It is found at all seasons, but most frequently during summer. The teraglin is of the same family as the jew-fish, though it does not reach an equal size. The air bladder is large, and of excellent quality, being of great value for the making of isinglass. The mackerel is obtained in enormous quantities off the coast, and sometimes even in the harbours. It is a good fish when eaten fresh, but it decomposes rapidly. The family of mugilidæ, or mullets, is well represented in Australian waters. The sea mullet is a large fish, often attaining a length of 2 ft., and a weight of 8 lbs. It is regarded by some authorities as unsurpassed in richness and delicacy of flavour by any fish in the world, and it visits the shores of New South Wales in countless numbers in the season when it is in the best condition. There are four species of gar-fish found on the New South Wales coast. The Sydney gar-fish is very abundant, especially towards the end of summer, making its appearance in shoals, sometimes of enormous size. The river gar-fish is even of better quality than the last-mentioned, but it is not so plentiful as formerly. The other species are seldom met with. There are numerous other varieties of fish found in the waters of New South Wales, many of which are very valuable as articles of food, but for the most part they are neither so numerous nor so easily obtained as those referred to. Destructive fishes are by no means rare, the shark family being largely represented, not only in the deep sea off the coast, but even in the harbours. The shark, however, is not absolutely valueless. The fins find a ready sale in the Chinese markets; the skin also has some commercial value, while from the liver is extracted a large quantity of valuable oil, equal in every respect to cod-liver oil. Several varieties of fish which have long since disappeared from other parts of the world are still represented in New South Wales. Amongst these is the cestracion, or Port Jackson shark, whose teeth resemble those of the fossil acrodis found in the mesozoic deposits. During the season the Australian waters teem with herrings, the season of immigration being the last six months of the year. There are four species, but two only are of commercial importance. The most valuable of this family of fishes is the pilchard. The Australian pilchard in a fresh state is equal in excellence to the Atlantic pilchard, and there is every reason to suppose that it can be obtained in quantities sufficient to enable competition to be entered into with the bloater and sardine of Europe. The maray also passes northward at the same time as the pilchard, and in like prodigious numbers, but both species keep well away from the shore. The rivers of the colony produce some most excellent specimens of freshwater fish. The Murray, Murrumbidgee, Lachlan, and Darling are the most plentifully stocked, the Murray cod (*Oligorus Mitchelli*) being perhaps the most highly esteemed of their fishes. The silver perch, and several kinds of the percidæ family, so highly prized for their delicacy, are plentiful in the rivers. Little systematic attempt has yet been made to acclimatise European varieties of edible fishes, although success would most probably attend any efforts in this direction, every difficulty having been overcome in Victoria, New Zealand, and Tasmania. Of oysters, two kinds occur on the coast of New South Wales—a large one considered to be a form of the English oyster, and popularly known as the mud oyster, and a smaller sort, the rock oyster.

THE GERMAN TOY INDUSTRY.

Although the little Thuringian town of Sonneberg, the centre of the modern toy industry, is commonly considered as the birthplace of toy making, it appears, according to a German trade journal, that the first attempts in the art were made by the village of Judenbach, situated further to the north-east. By reason of its favourable situation near the Nürnberg Sächsische Geleitsstrasse, a road much frequented ever since the 13th century, and the only means of communicating with Leipsic and Nuremberg, the village could always readily dispose of its crude wooden house and kitchen utensils, and later of its little chairs, tables, animals, cross-bows, swords, guns, and musical instruments. Even long after the art of making woodenware had been introduced in Sonneberg, Nuremberg was still the market for these peasant products, and continued to make the most of the transaction. Not without reason did the city call Sonneberg its Goldtöchlein (little gold

daughter). Not until the Thirty Years war had destroyed all the regular trade communications did the Sonneberg tradesmen themselves begin to travel about with their wares. The inhabitants of Judenbach, on the other hand, would never leave their native village in order to sell their products. While in Judenbach the toy industry did not attain great proportions, in Sonneberg the trade, as early as the 17th century, had grown to such an extent that when public markets were established in Frankfort-on-the Main, the merchants of Sonneberg were granted equal exemption from taxes and duties with the merchants of Nuremberg. Till the 18th century toys were coloured with poisonous bismuth paints. An important step in the development of the industry was the endeavour to make those parts which were difficult to carve out of some doughy substance (rye flour, mixed with lime water). This substance, however, softened and mildewed when moistened. A decided advance was recorded only when Friedrich Müller, a citizen of Sonneberg, began to use *papier maché*, a substance of which he had heard from a French soldier. The figures were no longer modelled as before, but the plastic mass was now pressed into shape by moulds. By means of this new substance Sonneberg produced its wares with almost mechanical rapidity. Toys are no longer made in the peasants' houses, but in factories. The cost of these new wares was, moreover, considerably reduced—a most significant factor in the manufacture of toys. In the making of dolls but little progress was made. Not until a new method was introduced into Sonneberg, which came from China by way of England, can any great improvement be recorded. From the first Chinese dolls of 1852, with the movable limbs, strung together by cords drawn through the joints, developed the so-called "jointed dolls." In colouriog the faces of these dolls, white lead, a poisonous paint, was long employed, until by legislative action its use was prohibited. Nowadays, the innocuous zinc oxide, and similar harmless colours, are used. The hair of dolls, after many failures of other materials, is now made of mohair and the fur of Angora goats. In this manner the toy industry slowly developed to its present state. How numerous are the varieties of toys now made may be inferred when it is considered that the design room of a Sonneberg factory contains from 12,000 to 18,000 designs. In order to maintain the position which they have reached, toy makers are compelled constantly to bring forth new models, and to adapt their products to the tastes and peculiarities of foreign purchasers. Years ago, the Chairman of the Sonneburg Chamber of Commerce proposed the collection of toys made by foreign manufacturers, in order that Sonneberg toy makers might thus be able to acquaint themselves with the wants and peculiarities of foreign markets. Such a collection of models has now been made, and does good service for the manufacturers as well as for the students at the various industrial schools of Thuringia. The toys at present may be divided into the following groups:—1. Wares made entirely of wood, such as cross-bows, guns, violins, flutes, chess and draught boards, rattles, jumping mannikins, nutcrackers, soldiers, ninepins, rocking-horses, &c. 2. Articles made mostly of wood, such as doll-houses, kitchens, shops, furniture, punch and judy shows. 3. Mechanical toys. 4. *Papier maché* articles, such as harlequins, riders, caricatures of national types, animals covered with felt or leather, shepherd's houses, menageries, figures of Santa Claus. 5. Animals covered with fur. 6. Metal toys, such as tin figures, toy trumpets, weapons and theatres. 7. Figures and toys made of china, burnt clay, stone, and glass. Among these toys may be mentioned toy dishes, marbles, and articles of various kinds made of blown glass. 8. Christmas-tree decorations of glass, metal, and wax. In Lauscha wax is the material most used. 9. Dolls, with wagons, chairs, and swings. Besides Sonneberg, the towns and villages of Watterhausen, Friedrichsroda, Ohrdruf, Hildburghausen, Schleusingen, and Koburg are engaged in the industry. Toy factories are now scattered more or less over one-half of Germany; they are distributed from the Black Forest and the Palatinate of the Sudetic Mountains, and the province of Brandenburg. Of particular importance are the Erzgebirge of Saxony, which on account of their forests and abundant water power, have enabled the manufacturers of Saxony to produce many of the more common toys formerly made in Sonneberg. The most recent statistics show that Germany has exported toys to the value of 40,500,000 marks (£2,025,000), while in 1895 the value was only £1,500,000. Including the toys sold in Germany, the product of the entire German industry is probably worth 50,000,000 marks (£2,500,000), from which 750,000 marks (£37,000), representing the value of toys imported from foreign countries, must be deducted. Sonneberg undoubtedly produces half the toys made in Germany. The two largest buyers of German toys are the United States and England. In 1897 this country imported German toys to the value of 17,000.000 marks (£850,000). To the development of toy manufacture, and to the rise of doll making, is due the increase in the number of export houses in Sonneberg. In the sixties there were about thirty export firms. By 1880 the number had increased to forty-eight, and by 1896 to seventy. According to the latest statistics there are 40,829 persons engaged in German toy manufactories, of which number 44 per cent. are employed in Sachsen, Meiningen. In the region of Sonneberg about 34 per cent. of the population are engaged in toy making, not including those who in addition are otherwise employed.

General Notes.

Haulage in Mines.—At a recent meeting of the Engineers' Club of Philadelphia, Mr. H. K. Myers

read a paper on modern mine haulage, describing the methods applied in American collieries. He estimated that the production of 200,000,000 tons of coal last year required 2,000 miles of railway lines in main roads and 5,000 miles in workings. This showed the importance of the problem of mechanical mine haulage. In order to compare a mule and a locomotive for mine haulage, the author has calculated that both the former and the latter can produce a maximum tractive effect of one-fifth, and an average of one-seventh, of its own weight.

Photography a Test for Reagents.—Messrs. Lumière Bros.' process of development with acetone, &c., has been put to a novel use by them in detecting the presence of these bodies by their photographic behaviour. To apply the test, 25 c.c. of an aqueous or alcoholic solution of the substance under examination is mixed with double the quantity of solution containing 7 per cent. sulphite of soda, and 1½ per cent. of pyrogallol or a similar hydroquinone solution, and applied to a plate acted upon by light. A similar test solution is diluted with an equal bulk of water, and applied also to an exposed plate, and the two plates are compared. The method is so sensitive, that it will detect formaldehyde (formalin) diluted 25,000 times, acetaldehyde 15,000, and acetone 2,500 times.

Mines in Servia.—Mr. E. Hegner, says the *Mining Journal*, has contributed to the *Montan-Zeitung* an account of the coal-mining industry of Servia. Although Servia has more than enough coal and lignite for its needs, foreign coal is imported every year in increasing amounts. Not more than a dozen collieries are in operation, and most of these are worked in a very primitive manner. The Morava Tertiary basin, near Alexinatz, is described in detail. It is twelve miles long and five miles wide. It is traversed by the State Railway, and contains numerous seams of excellent coal, some of which have been worked for the past fifteen years. The average selling price of the coal is 6·25 francs a ton. The cost of mining per ton is :—Wages, 2 frs. ; material, 0·25 fr. ; transport to the railway, 1·70 fr. ; royalty and administration, 0·45 fr. ; total, 4·40 frs.

Wood Pulp. — The process of manufacturing mechanical wood pulp is described by Mr. W. A. Hare in a volume just received, containing papers read before the Engineering Society of the School of Practical Science, Toronto. Within the past two or three years there has been a marked impetus given to the pulp and paper industry in Canada. Wood pulp will, for many years to come, be used to supply the world's demand for a filler in the manufacture of paper, in many of the coarse grades of which it is the only constituent. It is not confined, however, to the manufacture of paper alone, but is made into many useful articles of daily service, the market for which is increasing rapidly. No country in the world is better adapted than Canada for the establishment and expansion of wood pulp manfactures ; and a prosperous future may be anticipated for the industry.—*Nature.*

Jewish Colonies in Jaffa.—The most advanced and fertile of the colonies in the neighbourhood of Jaffa, according to Consul Dickson, are the Jewish colonies. The vintage was very abundant last year, especially in the colony of "Richon-le-Zion." The following are, as nearly as possible, its returns of the manufacture of wine and cognac, given, unfortunately, in weight only :—Wine, 1,680 tons ; cognac, 84 tons. Great hopes are entertained for further improvement in the quality of these wines, which are equal in flavour to many of the French wines. The settlers in the colony of "Petah-Tikva" have begun to plant a large part of their grounds with orange trees. It is estimated that the area destined for orange plantations is equal to that of one hundred of the average sized Jaffa gardens. The Agricultural School — "Mikueh Israel" — belonging to the "Alliance Israelite" of Paris, and situated on the carriage-road to Jerusalem, at half an hour's distance from Jaffa, is steadily progressing. There are always in this school about 100 resident pupils, who are boarded, clothed, and instructed at the expense of the "Alliance," and many of the pupils who finish their studies in this school are sent to Paris, and after they have ended their course of studies in the French capital go as teachers to the different schools maintained by the "Alliance." In this way the pupils have a promising career opened to them. The institution at "Mikueh" has devoted a large part of its ground to viticulture. The wine produced is extremely good, the last vintage having yielded 111 tons. The plantation of mulberry trees for the breeding of silkworms is also being extended.

The Malay Peninsula.—According to a paper recently read by Mr. Hugh Clifford before the Royal Colonial Institute, in 1875 the revenue of Perak was only $226,233, compared with $2,776,582 in 1889, while the revenue of all the federated Malay States was only $881,910 in 1880, against $7,000,000 last year. All this revenue raised in the federal Malay States was devoted solely to the development of Malaya.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 26...British Architects, 9, Conduit-street, W., 8 p.m.

Tuesday, June 27...Photographic, Russell-square, W.C., 8 p.m. Reception by the President.

Wednesday, June 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.
Colonial Inst., 9 p.m. Conversazione at the Natural History Museum, South Kensington.
Sanitary Institute, 74A, Margaret-street, W., 8 p.m.
Japan Society, 20, Hanover-square, W., 8½ p.m. Annual Meeting.
British Astronomical, Sion College, Victoria-embankment, W.C., 5 p.m.

Thursday, June 29...Hellenic Society, 22, Albemarle-street, S.W., 5 p.m. Annual Meeting.

Journal of the Society of Arts.

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FRIDAY, JUNE 30, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS.

The results of the Examinations held at the end of last March are now ready, and an advance copy has been sent to each centre of examination.

Copies for gratuitous distribution to each candidate who attended the examination will shortly be sent to each centre. Additional copies can be obtained, price 6d. each.

The dates for the Examinations in 1900 will be Monday, Tuesday, Wednesday, and Thursday, March 26th, 27th, 28th, and 29th.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments, during the past year, and also for the Election of Officers, was held in accordance with the Bylaws on Wednesday last, the 28th inst., at 4 p.m. Sir John Wolfe Barry, K.C.B., LL.D., F.R.S., Chairman of the Council (followed by Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.), in the chair.

The Secretary read the notice convening the meeting, and the minutes of the last annual meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society :—

Boyle, Sir Cavendish, K.C.M.G., 100, Piccadilly, W., and Georgetown, British Guiana.

Carter, William Leonard, 51, Aynhoe-road, Kensington, W.

Hozier, Colonel H. M., C.B., Lloyds, E.C.

Jennins, Henry Horwood, Crown Works, Leeds, and West-hill, Chapeltown, Leeds.

Khan, Sultan Mohammed, Christ's College, Cambridge.

Nesbitt, Thomas Huggins, Vestry-hall, Mount-street, Grosvenor-square, W.

Phillips, George A., The Grange, Hever, Kent.

Sorabji, Shapurjee, 49, Leadenhall-street, E.C.

Syad Mahomed Latif, Khan, Bahadur, Shams ul Ulema, District Judge, Jallandhar City, Punjab, India.

Thornton, H. G. Blake, Constitutional Club, W.C.

Walker, Charles Maynard, 304, Fulham-road, S.W.

The Chairman nominated Mr. John Jewell Vezey and Mr. Carmichael Thomas, scrutineers, and declared the ballot open.

The Secretary then read the following

REPORT OF COUNCIL.

I.—Ordinary Meetings.

The business of the present Session—the 145th since the foundation of the Society in 1754—was commenced on the 16th of November last, when the Chairman of the Council, Sir John Wolfe Barry, in accordance with the usual practice, delivered an Opening Address. The Chairman took for his topic the Internal Traffic of London. He showed how rapidly it had increased and was increasing, and suggested various means for the alleviation of its present congested condition. The address, dealing as it did with a subject which was already much in the public mind, attracted a great deal of interest, and was largely commented upon in the newspapers. It has already borne useful fruit in the extension of police measures for the regulation of a certain amount of traffic, while it appears likely that further powers will be entrusted to the police with the same object. It is to be hoped that the constructive measures suggested by the Chairman for the improvement of the means of communication may also receive consideration, and be eventually carried into effect.

The first paper read after the Opening Address was by Professor Forbes, who dealt with the question of the "Long Distance Transmission of Electric Power." Professor Forbes had recently returned from a visit to Egypt, where he had been examining and reporting on the water-power which would be developed by the new works for the barrage of the Nile. He dwelt strongly on the importance of employing the various great sources of water-power known to exist, even suggesting as

feasible the utilisation of the Victoria Falls of the Zambesi. A proposal which he made to get over one of the main difficulties—the cost of the large copper mains required for distant transmission—by means of a mortgage on the copper, gave rise to a good deal of discussion.

Four other papers read during the Session dealt with various applications of electricity. At one of the meetings in February, Mr. James Swinburne introduced Nernst's Electrical Lamp to this country, and gave an interesting account of this new and remarkable invention, in which the carbon filament of the ordinary incandescent lamp is replaced by a thin rod of highly refractory oxides. Such a rod will remain incandescent in the atmosphere without appreciable waste, so that a surrounding vacuum is not required. The lamp is certainly very ingenious, and very simple. If the anticipations of its inventor are realised, it ought to work a revolution in electric lighting. Another application of electric power formed the subject of Mr. Philip Dawson's paper on "Electric Traction." Mr. Dawson gave a compendious account of the principles involved in this application of electricity, and of the application of these principles, so far as they have as yet gone both in America and in Europe. A little later there were two papers dealing with the older application of electricity—the conveyance of information, not of material substances—one by Mr. John Gavey on "Telephones," and one by Sir William Preece on "Aetheric Telegraphy." Mr. Gavey described the mechanism and organisation by which the telephone system has been brought to its present perfection, while Mr. Preece gave an account of the various methods, including his own, by which signals have been transmitted through space without the use of any communicating wire.

The various applications of engineering science received in this session a large share of attention. The first paper that may be classed under this head was the one on "Inland Navigation," by Mr. Vernon-Harcourt. The question of inland navigation is one which has been dealt with on various occasions by the Society of Arts, a special Conference having been held in 1888. Mr. Harcourt gave an account of the present condition of inland navigation in Europe and America, and compared it with the condition of things at home. He urged that the British waterways should form the subject of a careful and thorough inquiry, with a view to their development for the carriage of heavy goods, and also suggested that the Board of Trade should be requested to collect complete statistics indicating the recent growth or decrease of traffic on waterways. The subject of "London's Water Supply" was treated by Mr. Walter Hunter. Mr. Hunter dealt with the case of the water companies, and showed how efficient and satisfactory their service to London is at the present time. At the meeting succeeding Mr. Forster Brown read a paper on "Coal Supplies," and suggested the measures which he thought ought to be taken, in view of the possible exhaustion of our coal, to place the country in a satisfactory economic and manufacturing position before the time arrived when the want of coal began to be felt. Another mining paper had been read a little earlier in the session by Mr. J. H. Collins, who gave a very complete account of the Cornish mines and their present condition. His opinion was that the mines in Cornwall only required further working capital to make them as profitable an investment as the perhaps more attractive, and certainly more popular mines in other parts of the world. The supply of liquid fuel, which formed the subject of a paper by Sir Marcus Samuel, may be treated as belonging to the same class as the papers just mentioned. Sir Marcus gave a very vivid idea of the enormous extension which has lately taken place in the use of petroleum for domestic lighting in the Far East and elsewhere.

Another set of papers may be grouped together as dealing with questions of a social or economic character. The first of these was the one read by Sir Albert Rollit on "Commercial Education." Sir Albert laid great stress on the necessity for improvement in commercial education, showed what had been done up to the present in that direction in this country, and indicated the lines on which he thought further development ought to follow. The next to be mentioned is Mr. Dixon H. Davies' paper on "The Cost of Municipal Enterprise." Mr. Davies treated a very difficult question with much skill, taking the side of those who looked upon municipal enterprise as an unwise interference with the development of private industry and trade, and asked for a Commission which might eventually provide the basis of legislation to indicate the limits which should be set upon such trading. The paper gave rise to an important discussion, lasting over a second evening. The third paper of this class was one on "The Law of Trade Marks," read by Mr. J. E. Evans-Jackson at the concluding meeting of the

session. Mr. Jackson pointed out that we had now had considerable experience in the working of the present law, and that the time had arrived when its revision and reform in certain directions was required.

Two papers dealt with foreign countries and their resources. Mr. W. T. Maud, who had served as special correspondent of the *Daily Graphic* during the Egyptian campaign, gave a graphic and interesting sketch of Egypt and the Soudan in 1897 and 1898; and Mr. James Irvine, who has previously contributed important material to the Society's transactions, gave an interesting account of the gold mines of West Africa, their present condition, and the developments which they required.

The remaining papers do not lend themselves to ready classification. At the second meeting of the session Mr. C. H. Bothamley read an excellent paper on "Photographic Developers and Development." It was a very clear and compendious account of the progress which has been made in this branch of photographic chemistry. Very few years ago there were but two substances upon which photographers could rely for the development of the latent image—one a salt of iron, ferrous oxalate, and the other the hydrocarbon compound, pyrogallic acid or pyrogallol. Since 1880, when Captain Abney introduced the use of hydroquinone, photographic developers have greatly increased in number, though it may be doubted whether the results of their use have shown any great advance. Mr. Bothamley gave, in a popular and intelligible form, an account of the various substances which are now employed, and, so far as they are known, the general reasons for their action.

At the first meeting after Christmas, Mr. W. Hunting read a paper on "Tuberculosis in Animals," pointing out how closely associated this disease is with tuberculosis in the human subject, and advancing the proposition that, without checking the one, it would be impossible to get rid of the other. A little later in the session, the Rev. J. M. Bacon gave an interesting account of his recent meteorological and other researches carried out in balloon ascents, researches which it may reasonably be hoped will have an important practical value. Mr. Wilton Rix, in his paper on "Leadless Glazes," dealt with one branch of a subject of the greatest importance to our manufacturing industries—the regulation of the use of dangerous materials in industries, so that injury to the workers may be avoided without undue interference with the industry itself. An important industry, and though one of the oldest, yet one which is receiving considerable recent development, was dealt with by Mr. Bunyard in his paper on "Fruit-Growing in Kent." Mr. Bunyard's account of the present condition of this important branch of agriculture was satisfactory and full of hope for the future.

II.—Indian Section.

This Section has had another successful session. The standard of the papers, six in number, has not been inferior to that of previous years, while the discussions generally have been of exceptional interest and value. That the work of this department of the Society is appreciated, not only at home but in India, is shown by the large amount of attention the Section's meetings obtain from the Indian Press, and by the frequent applications for membership received from our Eastern Empire.

The session commenced on January 19th, when Dr. John Nisbet dealt with the proposal to continue eastwards the important railway now in course of construction from the Upper Burma capital to the Salween River, the object being to tap the trade of Yunnan, "presuming that there is any trade worth tapping." Dr. Nisbet thinks that it would be wiser to develop railways within the province itself, and to establish a connection with Assam, than to penetrate far in the direction of Western Yunnan. His doubts as to the commercial value of that region were shared by the Chairman, Sir Alexander Mackenzie, who declared that "it would be monstrous to expend the revenues of India in extending the railway beyond British territory into China." On February 9th the Chief Commissioner of the Andamans, Colonel R. C. Temple, read a paper giving a description of the penal system in force at that settlement, the largest establishment of the kind in the British Empire, and perhaps the largest in the world. Of the 12,000 "lifers" in the Andamans 250 are regarded by Colonel Temple as positively dangerous; the same number as requiring permanent imprisonment; and the remainder as capable of being brought to a considerable height of respectability by continuous education in self-restraint. They are employed in all sorts of industries, doing "anything that the labourers of a whole community do." "Leprosy in India" was the subject of a paper read on March 9th by Mr. H. A. Acworth, who

distinguished himself as Municipal Commissioner of Bombay—a post similar to a French prefectship—by establishing in 1890 the well-known Matoonga Leper Asylum, and who may claim to have originated the policy of segregation embodied in the Acts since passed by the Viceregal and Bengal Legislative Councils. Mr. Jonathan Hutchinson spoke in the discussion on Mr. Acworth's paper. On April 27, Sir John Scott, in his paper entitled "Judicial Reform in Egypt," gave the first account presented to a London audience of the "great work," to use Lord Dufferin's words, he carried out as Judicial Adviser to the Khedive; and on May 11, Mr. F. O'Dwyer contributed a comparison of the Punjab revenue system and that of two leading Rajput States of which he is the Settlement Officer. The Session concluded on June 1 with a paper on "The Port of Calcutta," by Sir Charles Stevens, who included a sketch of the circumstances that led to the establishment of the Bengal capital as an emporium, and an explanation of certain ingenious engineering schemes for overcoming some of the difficulties connected with the River Hugli.

For the sixth year in succession three of the meetings of the Session were held at the Imperial Institute.

III.—Foreign and Colonial Section.

To this Section were contributed four valuable papers on matters of great and present interest. The first of the series was that of Mr. Archibald Little, on "The Yangtse Basin and the British Sphere," with which the session opened on December 6. Mr. Little, the highest living authority upon the subject, as the Chairman (Sir Richard Temple) styled him, described the basin of the Yangtse—the watershed of which comprises a third of China proper—as one of the richest, if not the richest, subtropical region on the world's surface, and as inhabited by a people as hard working as that of the United States, with which it has many points of analogy. On January 24, Mr. W. Fischer Wilkinson, who spent nearly the whole of last year in travelling about the mining districts of that portion of South Africa, named after the founder of the Chartered Company, set forth the results of his investigations in a paper, entitled "Rhodesia and its Mines in 1898." That the mineral wealth of Rhodesia will prove to be its only source of prosperity is not Mr. Wilkinson's view. In his opinion the future of the country "is bound up with its pastoral and agricultural possibilities." The high veldt, with an elevation of 4,000 ft., is, he mentions, particularly suitable for farming. His impression, as an independent and impartial observer, is that settlers have every reason to be satisfied with the manner in which Rhodesia is being administered by the Chartered Company. On February 28, Mr. A. Hotz read a paper on "Persian Trade Routes," insisting, from his extensive mercantile experience, on the urgent need for replacing the existing inadequate and antiquated mule tracks with a network of proper roads. While Russia is bestirring herself to remedy this evil in the North, the attitude of England in the South is, according to Mr. Hotz, one of "indifference." Thanks, however, to private enterprise, something is being done, and a road from Schuster to Ispahan is now in course of construction. At the concluding meeting, on March 21, Mr C. Rozenraad read a paper on the recent remarkable commercial development of Germany, the origin of which he traces to the foresight of Bismarck, particularly in his creation of the Imperial Bank of Germany.

IV.—Applied Art Section.

For various reasons considerable alterations had to be made in the original programme of this Section. Three of the papers announced for reading had to be withdrawn, namely, those by Sir William Richmond on "Craftsmanship," by Mr. George Lock on "Domestic Furniture," and by Mr. William Burton on "Maiolica." In place of these were substituted papers by Mr. Stephen Webb on "Intarsia or Inlaying," and by Mr. I. Hunter Donaldson on "The Artistic Treatment of Picture Frames."

In the first meeting of the Section, Mr. Edward F. Strange gave an account of the Centenary Exhibition of Lithographs, which, as is stated in another portion of this report, the Science and Art Department were at that time holding at the instance of the Council of the Society. Mr. Strange, after an instructive criticism on the works of the different schools, both foreign and English, laid stress on the value of lithography as a medium by means of which the artist's own work is exactly reproduced, and expressed the opinion that in spite of the recent revival of the art there was room for a much greater development. He hoped, therefore, that artists would devote more attention to it in the future. The second paper of the Section was on "Vitreous Enamels," by Mr.

Cyril Davenport. Mr. Davenport's paper dealt chiefly with the ancient examples which showed the art in its greatest beauty, and drew special attention to the high position which England had taken in the development of the art of enamelling. A special feature of the paper was its illustration by a series of very beautiful lantern slides, prepared by Mr. Davenport from originals principally in the British Museum.

Mr. Stephen Webb's paper on "Intarsia," above-mentioned, was the next in order. Mr. Webb gave a very interesting account of this beautiful minor art, and illustrated his remarks with some fine specimens of his own work. In his paper on "Picture Frames," Mr. I. Hunter Donaldson dealt with a subject of great importance to painters, but one which appears to have been very much neglected by them in the past. During the last and the greater portion of the present century the frame makers were allowed to supply the most tasteless productions, in the making of which they had entirely fallen away from the better taste of the 16th and 17th centuries. Of late certain of our chief artists have realised how much their pictures gain by appropriate aad elegant frames. Mr. Donaldson's paper was supplemented by some very interesting speculations by Sir George Birdwood on the archæology of the subject. The last paper in the section was by Mr. J. Starkie Gardner, on "The Revival of Tradesmen's Signs." Mr. Starkie Gardner, to whom the Society has previously been indebted for very valuable contributions on the subject of art metal-work, dealt to a large extent with the work of the older craftsmen, who designed the wrought-iron signs which formed the exemplars of those which are now making their appearance in the streets of London.

V.—Cantor Lectures.

The first course of Cantor Lectures this session was delivered by Professor Vivian B. Lewes, on the subject of "Acetylene." It will be remembered that the application of acetylene for illuminating purposes was first described in this country in a paper read by Professor Lewes before the Society in January 1895. Since that date he has devoted a great deal of attention to the subject, and his lectures included the results of a great deal of original work. Coming, as the course did, so soon after the holding of the Exhibition of Acetylene Generators at the Imperial Institute last year, and the Report upon them by the Society's Committee, the lectures formed a most valuable supplement to that Report, and there has been, since their publication, a great demand for them.

The second course was by Dr. Samuel Rideal, on the "Bacterial Purification of Sewage." In it Dr. Rideal gave his audience the latest results of the investigations which have been made with a view to the application of the recent extension of bacteriological knowledge to the solution of the important problem of sewage disposal. This problem has often been before the Society of Arts, and, indeed, it was the action of the Society in holding its Conferences on Public Health, in the years 1876, 1877, and 1878, that principally induced public attention to the subject. The records of the Society show, from time to time, what advances have been made; and the most recent advances were those described by Dr. Rideal in his lectures.

Mr. Sharp, in his course on "Cycle Construction and Design," dealt with a subject which is just now extremely popular. Mr. Sharp has given great study to the mechanics of the cycle, and there is, perhaps, no one better qualified to deal with the subject from a scientific point of view. His lectures embodied a great deal of valuable information, and may be said to have brought the subject of cycle construction down to the most recent date.

The last course of lectures was by Professor Henry Procter, on "Leather Manufacture," a subject of great practical importance, and one which may fairly be considered as a London industry. Although the practical treatment of skins in the process of making them into leather is not very different from that which was arrived at long ago by purely empirical methods, there have been great advances in the scientific knowledge of the subject, and consequent modifications in the methods of the process. Mr. Proctor, who is Professor of Leather Industries at the Yorkshire College, Leeds, was able to give the Society the benefit of extended theoretical as well as practical knowledge of the subject.

VI.—Juvenile Lectures.

Two Juvenile Lectures were delivered by Professor Jeffrey Bell during the Christmas holidays. The subject was a zoological one, and may be said to have dealt with the mechanics of animal construction. They were well attended, and much appreciated by the audience of members and young people which listened to them.

VII.—Albert Medal.

The Albert Medal for the present year has been awarded by the President and Council to Sir William Crookes, F.R.S., for his extensive and laborious researches in chemistry and in physics, researches which have, in many instances, developed into useful practical applications in the Arts and Manufactures. Sir William Crookes was among the first to employ the spectroscope as an instrument of chemical research, and by its aid, in 1861, he discovered the metal thallium, the earliest of the series of the "rare metals." To his researches was also due the discovery of the various earths now so extensively employed in obtaining a large increase of light from illuminants. In 1872, he began the long series of experiments on radiation, of which the radiometer was the first outcome. This work on molecular physics in high vacua led to methods of producing extremely high vacua, which made possible the construction of the incandescent lamp. They also enabled the remarkable properties of the cathode rays (which are affording such important results in connection with surgery) to be discovered and developed. He has rendered important services to industrial chemistry, and long ago established a position as an authority on the chemistry of dyeing and calico printing. His work in connection with the chemistry of agriculture also requires to be noted. His services to pure science have been acknowledged by the award of a Royal Medal, and of the Davy Medal of the Royal Society; and it is the application of these researches to industrial uses which led the Council of the Society to submit his name to the President for the award of the Albert Medal.

VIII.—Medals.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1898-99.

At the Ordinary Meetings :—

To Prof. George Forbes, F.R.S., for his paper on "Long Distance Transmission of Electric Power."

To C. H. Bothamley, F.C.S., for his paper on "Photographic Developers and Development."

To Dixon H. Davies, for his paper on "The Cost of Municipal Enterprise."

To James Swinburne, for his paper on "Nernst's Electric Lamp."

To J. H. Collins, for his paper on "Cornish Mines and Miners."

To Philip Dawson, for his paper on "Electric Traction and its Application to Suburban and Metropolitan Railways."

To Walter Hunter, M.Inst.C.E., for his paper on "London's Water Supply."

To Sir William Henry Preece, K.C.B., F.R.S., for his paper on "Ætheric Telegraphy."

In the Indian Section :—

To Colonel Richard Carnac Temple, C.I.E., for his paper on "The Penal System at the Andamans."

To Sir John Scott, K.C.M.G., D.C.L., for his paper on "Judicial Reforms in Egypt in Relation to the Indian Legal System."

In the Foreign and Colonial Section :—

To Archibald Little, F.R.G.S., for his paper on "The Yangtse Basin and the British Sphere."

In the Applied Art Section :—

To Stephen Webb, for his paper on "Intarsia, or Inlaying."

To J. Starkie Gardner, F.G.S., for his paper on "The Revival of Tradesmen's Signs."

IX.—Swiney Prize.

The prize left by Dr. Swiney, to be awarded on every fifth anniversary of his death, was awarded in January last, that being the 55th anniversary of the testator's death. It has to be given to the author of the best published work on Jurisprudence, and the award is made jointly by the Society of Arts and the College of Physicians. On the occasion of the first award being made, the question was discussed between the two bodies concerned as to what share should be allotted to Medical Jurisprudence, and an arrangement was arrived at that the award should be made alternately to Medical and to General Jurisprudence. This plan has been continnously followed. The question was raised as to whether it would be desirable to revise it; but after consideration it was determined that there appeared to be no reason to disturb an arrangement which had worked well for the past 50 years, and that it should be continued, with the understanding that if at any time the joint Committee of the Society of Arts and the College of Physicians, which was usually appointed to submit a book to the adjudicators, should be unable to find a work of the class whose turn it was to receive the award, which appeared to them to be of sufficient merit, they should be at liberty to recommend a book belonging to the other class. As has been already announced in the *Journal** the prize for the present year was awarded to Dr. J. Dixon Mann for his work on "Forensic Medicine and Toxicology."

* See *Journal*, vol. xlvii., p. 173, January 27, 1899.

A list of previous recipients will be found in the *Journal* of the 28th of October last.*

The prize is a silver goblet of the value of £100, with gold coin to the same amount. The cup has always been made by Messrs. Garrard from a design by Daniel Maclise.

Dr. Swiney is interred in the burial ground, Pratt-street, Camden-town, and it was lately represented to the Council that the monument over his grave was falling into disrepair. Some years ago it was renovated at the expense of the Society, but the stone is of a very perishable nature, and the slight repairs which the Council thought it wise to execute at the time were insufficient to arrest its further decay. The Council have felt that the duty of preserving the monument of one of its benefactors might fairly be undertaken by the Society of Arts, and they have therefore obtained the consent of the Vestry of St. Pancras to allow them to replace the stone, which is now almost perished, with a fresh stone in facsimile.†

X.—Owen Jones Prizes.

These prizes have now been awarded annually since the year 1878. Owen Jones died in 1874. After his death a committee was formed to collect subscriptions for the purpose of founding a memorial. The money thus obtained was partly expended in erecting a monument over his grave in Kensal Green, and the balance (a sum of £400) was presented to the Council of the Society of Arts upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were awarded this Session, each prize consisting, in accordance with the regulations laid down for the administration of the Trust, of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.‡

The next award will be made this summer, on the result of the present year's examinations. Six prizes have again been offered for competition.

XI.—Prizes for Drawing.

Since 1889, the Council have placed at the disposal of the Royal Drawing Society, for competition among the candidates at its annual examination, 12 Bronze Medals, and, as usual, these medals were awarded for drawings sent in by students to the exhibition held by the Drawing Society in April last.

This Society is doing useful work, by its examinations and exhibitions, in encouraging the teaching of drawing in second-grade schools Its operations are extending annually, and the Council believe that the assistance given to its operations by the Society of Arts by means of these medals has been usefully bestowed.

XII.—Examinations.

It is very satisfactory to be able to state that the increase in the number of candidates for the Society's examinations still continues, indeed the rate of growth is larger than last year; 8,750 candidates entered this year, showing an increase of 1,114 over the number last year, 7,636. The figures for the past ten years are given in the following Table, which shows a continuous and steady increase. This indicates the estimation in which the Society's examinations have been held, and proves that they supply a want which is felt by the classes for whom they are intended. As the examinations commenced in 1854, they are now approaching the end of the first half century of their existence. At various times they underwent considerable modifications, but no alterations have been made in the scheme now for a good many years. They form the only scheme of commercial examinations which have achieved any practical success, and indeed they had achieved success before the recent demand arose for examinations in commercial subjects at all. They are founded on the principle that the surest basis for good commercial education is a sound general education. Although it is only to a small extent that the value of such education can be tested by examination, it is believed that the Society's examinations offer a useful test, and, at all events, they offer the only one which has yet been provided.

The 8,750 candidates worked in all 9,581 papers. For these the following certificates were awarded:—First-class, 796; second-class, 2,063; third-class, 2,833; while 3,123 failed to satisfy the examiners. In addition to these there were 427 certificates granted in elementary languages, and 339 in music. Putting these in the form of per-centages, we find the approximate per-centage of first-class was 8·3, of second 21·0, of third 29·56, while

* See *Journal*, vol. xlvi., p. 909, October 28, 1898.

† A note on Dr. Swiney will be found in the *Journal*, vol. xlvii. p. 660, June 23, 1899.

‡ See *Journal*, vol. xlvi., p. 797, August 26, 1898.

32·7 failed. These results are not unsatisfactory as compared with those of last year.

Year.	No. of Candidates.	No. of Papers worked.	No. of Centres.	No. of Subjects.
1890........	2,315	2,474	79	14
1891........	2,460	2,667	78	14
1892........	*2,928	3,143	96	13
1893........	3,702	3,916	109	13
1894........	4,106	4,376	131	14
1895........	4,777	5,108	146	14
1896........	6,111	6,568	197	16
1897........	6,919	7,513	221	19
1898........	7,636	8,372	243	19
1899........	8,749	9,581	260	23

* Total, with supplementary autumn examination, 3,351.

In recent years the per-centage of first-class certificates has fallen—last year it was 6·05. The per-centage of failures has varied from year to year—last year it was 26·1. As mentioned in last year's Report, it is evident that the increase in numbers has been accompanied by a decrease in quality, owing to the fact that in many cases the fees payable by candidates are paid from the funds now at the disposal of the County Councils, and that therefore a large number of candidates are induced to enter before they are fully prepared. No general attempt has been made to raise the standard, although it may perhaps be a fact that the standard tends slightly to rise. It is at all events a satisfactory point to notice that there is this year a very distinct increase in the better class of candidates, as shown in the larger number of first-class certificates taken.

Nearly all the commercial subjects show an increase. There is a slight falling of in the two musical subjects, and in Domestic Economy. In Harmony there are 167, as compared with 161 last year; but this slight increase is counter-balanced by the still greater falling off in Rudiments of Music, 341 having entered, as compared with 366 last year. For Domestic Economy there were 202 candidates, as compared with 206 last year. Turning to the subjects of a commercial character, it is to be noted that in Italian there is a falling off, only 18 candidates having entered, whereas there were 37 last year. Commercial Geography also shows a trifling decrease, 118 as compared with 120. All the other subjects show an advance. The largest subject of all is Book-keeping, in which 4,006 candidates entered—last year there were 3,730. The next largest is Shorthand—2,214, against 1,791 last year. The next most popular subject is Typewriting, with 462 candidates, as compared with 433 last year. In English there is a considerable increase—254 against 189; and there is also an increase in Arithmetic—282 against 259, although this important subject is not as popular as it certainly ought to be. Economics attracted 34—an increase over the 27 of last year; and Précis Writing 28, also an increase over the 17 of last year. Of the language subjects, French, as might be expected, is the most popular—there were 398, last year there were 322. And there were almost as many for Elementary French, 395—a considerable increase over last year's number, 218. The next largest is German with 263, as compared with 227 last year. Spanish shows a steady increase—107 against 92—and in Elementary, 58 against 41. For Portuguese there were 39—last year there were 26. It is satisfactory to be able to note that this year for the first time there have been a few candidates in Russian and in Danish—7 in the former, and 5 in the latter language. Too much stress cannot be laid on the importance, to those who are being educated for a commercial career, of the study of the less well-known modern languages, and the Society has for some years past kept some of these languages in its programme, although year after year no candidates entered. It is to be hoped that now that a beginning has been made a larger number of candidates may take up this branch of study, and enter for the examinations in future years.

The examiner in Arithmetic remarks that this year's examination has been marked by a perceptible increase in the number of successful candidates for honours, 9 having achieved the high standard required for a first-class and 29 that for a second-class. These candidates sent up very good papers, briefly but lucidly expressed, the reasoning clear, the work accurate, and neatly written. Every question was satisfactorily answered by some one or other. Many candidates sent up answers, right or wrong, to every question on the paper. The number of failures has largely increased. This seems to be due to the influx of a number of candidates totally unprepared for an examination intended to test not only accuracy in the performance of arithmetical operations, but also knowledge of the principles of Arithmetic, and capacity to apply reasoning based upon those principles to practical commercial problems.

The examiner in English considers that the results of this year's examination are not up to the usual standard. Of the 254 candidates, no less than 77 failed, while only 24 evinced sufficient merit to justify the award of a place in the first-class. Mistakes in spelling are fewer every year, but there is as much need as ever for more accuracy in the use of grammatical terms, and for the exercise of more thought about the structure of sentences, and the due subordination of their several parts.

The examiner in Book-keeping considers that the results of this year's examination show a decided improvement upon those of 1898, though the per-centage of passes is less. To some extent this may have arisen from the alterations made in the plan of the questions set, but to a considerable extent it arises from improved knowledge and grasp of the subject. The plan of setting two exercises, independent of each other, proved a great improvement over the old plan, in which a candidate making blunders in the first part of the exercise, would be necessarily wrong in the second. The difference in the degree of preparedness shown by the candidates was, as last year, extraordinary. The best papers evidenced excellent and workmanlike knowledge, and a gratifying feature of the examination is the marked increase in the number of first-class certificates; 68·32 per cent. of the candidates passed, and of these 10·41 took first-class, 26·58 per cent. second-class, and 31·33 third-class. The failures amounted to 31·68. Compared with last year, this shows a considerable increase on the per-centage of first-class, and also a considerable increase in the per-centage of failures. The second-class per-centage remains about the same, and the third-class per-centage is smaller than last year.

The examiner in Commercial Geography states that the papers sent in this year are very much better than on any previous occasion since he has been examiner. The subject selected—the Commercial Geography of the British Empire—seemed to be popular, and had been studied in an intelligent way, though a large number of candidates failed to distinguish between the political unity and the commercial heterogeneity of the British Empire, a very large proportion being evidently unaware of the existence of tariffs directed by one part of the Empire against the other parts. On the whole the questions were well answered. The true nature of the examination seems to be becoming understood, and this year there were fewer incompetent papers than in any previous year.

The sudden death of Mr. T. A. Reed, who had acted as examiner in Shorthand since 1889, following Mr. Frederick Pitman, who acted as examiner from 1882, when the examination was first established, threatened to cause serious delay in the publication of the results. Mr. Reed died after he had actually commenced the examination of the papers, but before it was completed. Fortunately, however, Mr. Allen W. Reed, who has for many years past assisted his father in the conduct of the examinations, was able to take the work up, and carry it through without any delay or inconvenience. He reports that though there has been an increase of 423 papers over the numbers of last year, there has been a larger proportion of failures than in the three preceding years, the first-class certificates being actually less in number than those of 1898; last year there were 68, but this year he is only able to recommend 53. These 53 papers are of a specially good character, some of them being really excellent examples of shorthand writing and transcription. The second-class papers also showed an improvement. With regard to the failures, it is noticed that a large percentage of those who presented themselves were quite unprepared for anything of the nature of a speed test. The majority of the failures appear to have occurred not from lack of knowledge of the theory of Shorthand, but from incapacity to write beyond a very low speed.

The examiner in Type-writing speaks highly of the character of the papers which have been sent in, although the lower-class papers showed relatively greater advance than the first-class. She remarks that the greatest difficulty is experienced by employers in finding first-class clerks, the young people who present themselves being half-educated or wholly uninstructed. And, as in former years, the examiner lays great stress on the importance, in the case of those who are seeking a situation as a typist, of their qualifying themselves by a good general education.

The examiner in Economics considers that there was a great improvement in this year's papers as compared with those of 1898. The complaint he has had to make in previous years of the neglect of economic history is not now called for—this year's papers have to a large extent removed that reproach. On the whole this year's results are satisfactory, and considerably better than those attained in previous years.

The examiner in Précis Writing says that many of the papers worked show a marked improvement upon those worked in previous years. Some of the papers are very good, and many show a decided advance in the habit of thought and discrimination.

The examiner in French considers that the advanced papers are not quite so satisfactory as those of last year, which was an exceptionally good year. He is however able to recommend a good proportion for the first-class, and on the whole the results are satisfactory. In the Elementary examination while the actual numbers have increased the proportion of those who have passed remains about the same.

The examiner in German while noting the considerable numerical increase also reports an improvement in the general result. The majority of the first-class work was, as usual, very satisfactory, and some of the second-class work was also very good; but the majority of the candidates showed a lack of knowledge of German commercial, scientific, and technical terms.

The examiner in Italian notices that while the papers of a small proportion of the candidates are the best he has ever had to deal with, a great many of the papers are unfortunately extremely bad.

The Spanish examiner finds the number of inferior papers this year remarkably few, the candidates showing considerable capacity in their way of dealing with the commercial portion of the paper.

The examiner in Portuguese finds the work on the whole satisfactory, although the increase in the merit of the papers does not keep pace with the increase in their number. The technical portion of the paper is, as usual, rather weak.

The standard of the Russian examination was purposely kept low this year, in the hope of encouraging candidates who had probably entered after only a short course of instruction. But, in spite of this, the examiner found himself uuable to pass more than one of the seven candidates who entered. To this one a second-class certificate was awarded. He, however, states that, considering the incomplete amount of preparation they had had, the work done by most of the other candidates was fairly good, quite sufficient to justify them in continuing their work in the hope of attaining success another year.

The same remark as to the standard applies to the papers in Danish. The papers sent in by one candidate were excellent, and the examiner felt justified in awarding third-class certificates to the other four who had entered.

The examiner in Domestic Economy considers that the papers sent in year by year show a continuous and steady improvement. The papers this year reach a very high standard indeed.

The examiner in Music thinks that on the whole the results of the examination in the Rudiments of Music were good—some of the elementary papers were extremely satisfactory. As regards the examination in Harmony, though some of the papers, both for the higher and elementary certificates, were praiseworthy, there was a very large proportion of failures, especially in the higher class.

The Council have, as in previous years, to acknowledge the assistance they have received from many of the City Companies. The Clothworkers offered special prizes for certain of the language subjects, and the following Companies subscribed to the special Prize Fund, out of which money prizes are provided for the other subjects*:—Goldsmiths, Merchant Taylors, Mercers, Skinners, Leathersellers, and Salters.

XIII. — Practical Examinations in Music, 1898.

The practical examinations in Music for 1898 were not concluded until the 13th July, too late for the results to be included in the last Report of the Council.† They were, however, published in the *Journal*.† The examination lasted for 15 days.

The system of examination was the same as that which has been carried on for the last three years. Candidates are asked to select for themselves which of four standards they choose to be examined in. Standard I. is easy, Standard II. moderately difficult, Standard III. difficult, and Standard IV. very difficult. For each standard a list of music is given, and a selection from this list is sent to the candidates six weeks previous to the examination. Candidates are expected to play pieces from the selected list, as well as to play a piece, or portion of a piece, at sight.

In all 539 candidates were examined, an increase of 147 over 1897; 5 of these took up two subjects, so that there were 544 examinations. Of these there were 515 passes and 29

* The Clothworkers' Company's Prizes are offered in Italian, Spanish, and Portuguese.

† See *Journal*, vol. xlvi., p. 845, Sept. 23rd, 1898.

failures. The failures in 1897 were considerably larger in proportion, being 44 in 405 examinations.

The following were the subjects taken up :—Piano, singing, violin, violoncello, mandolin, zither, and organ. 399 entered for the piano, of whom 376 passed and 15 obtained medals; 79 entered for the violin, of whom 75 passed and 15 obtained medals; 1 entered for the violoncello and passed; 1 passed for the mandolin; 4 entered and passed for the organ; 59 entered for singing, and 57 passed, 5 obtaining medals; 1 entered for the zither and passed.

Mr. John Farmer, of Balliol College, Oxford, and director of the Harrow Music School, acted as Examiner, Mr. Ernest Walker, M.A., Mus. Bac. Oxon., and Mr. Burnham Horner, as Assistant-Examiners.

XIV.—Practical Examinations in Music, 1899.

The Practical Examinations for the present year have not yet been concluded. They commenced on the 26th June, and will be finished on or about the 12th July, after which a summary of the results will be given in the *Journal*. No alterations have been made in the system adopted in 1896, and continued since. In 1896, the first year in which the new system was tried, there were 376 candidates, in 1897 there were 392, in 1898, 539, and for the present year 551 have entered.

XV.—Acetylene Exhibition.

The steps which were taken by the Council, at the request of the Imperial Institute, for the examination of the Acetylene Generators exhibited at the Institute last summer were detailed in the last Report of the Council. After the exhibition was opened, it was suggested that a further set of experiments should be carried out on the very representative collection of apparatus which had been brought together, and an application was made to the Society's Committee that they should continue their labours, and report on the working of the generators after they had been put to the test of a month's practical experience. The members of the Committee, at the request of the Council, were good enough to undertake this somewhat arduous duty, and arrangements were made for the practical testing of all the apparatus shown.

As the result of these tests a great deal of information was collected, which was eventually embodied in a Report, which was published in February last. The Report itself was printed in the *Journal*.* It was also published separately, with appendixes giving particulars of the tests, diagrams of the apparatus and other information. It had been hoped that the report would have been ready sooner, but the mass of information which had to be dealt with prevented its publication being possible at an earlier date.

The Committee expressed their indebtedness to two of their members—Professor Vivian B. Lewes and Mr. Boverton Redwood—and they also acknowledged the value of the services of Mr. Duffield, who was engaged for the practical management of all the tests, and who carried them out with very great care and attention. The Council have reason to believe that the report has been of considerable value. There has been a large demand for it, and it appears to be much appreciated by those who are interested in this new method of lighting.

XVI.—Exhibition of Lithography.

In the course of last summer a suggestion was made to the Secretary of the Society by Mr. Joseph Pennell that the Society of Arts should organise an exhibition of lithographs to commemorate the centenary of the invention of lithography by Aloys Senefelder in 1798, the year in which, according to all the evidence now available, the invention was perfected. The special reason for the Society of Arts being asked to interest itself in the matter was that it was the first to recognise the invention in this country by the award of its Gold Medal to Senefelder in 1819.

The proposition was in due course laid before the Council and was approved of by them. A committee was formed, and arrangements were made for holding an exhibition of lithographs in the Society's house. It soon appeared that such an exhibition would require far more space than is available on the Society's premises, and the Council, therefore, applied to the Stationers' Company to know if they would lend their hall for such a purpose. The Court of the Stationers' Company at once acceded to the application, but it was found that even with this assistance the cost of the exhibition would be considerable, and the Council, therefore, made a suggestion to the Science and Art Department that they should take charge of the proposed exhibition. After some consideration, the Department agreed to undertake the work, and it was

* See *Journal*, vol. xlvii., p. 289, February 24th, 1899.

announced in the *Journal* in September last that an exhibition of lithography would be held in the buildings of the South Kensington Museum on the west side of Exhibition-road. The committee which had already commenced the organisation of the work on behalf of the Society was asked to continue their labours on behalf of the Department, and some additions were made to it. The exhibition was opened on November 21, and remained open until the end of February. A large and widely-representative collection of historical and artistic lithographs was obtained, and there was also a small set of examples of modern industrial lithography exhibited at the request of various firms who made application for space. It included over 2,250 examples, and showed a larger number of artistic lithographs than had ever been publicly exhibited before.*

The Council feel much indebted to the authorities of the Department for acceding to their suggestion, and for carrying it out in so complete and admirable a manner.

XVII.—Deterioration of Paper.

In the last Report of the Council an account was given of the proceedings of the Committee on the Deterioration of Paper, and it was stated that the Report of the Committee on the subject would shortly be issued. This Report was published in August last. It contains, as well as the conclusions of the Committee themselves, two appendixes—one, an abstract of official publications bearing on the subject of paper, and issued by the German Imperial Testing Station, and the second a précis of the information and suggestions submitted to the Committee by their correspondents.

XVIII.—Municipal Trading.

In the discussion on the paper on this subject, read before the Society by Mr. Dixon Davies, a suggestion was made that Her Majesty should be asked to appoint a Royal Commission to lay down the principles and limitations on which Parliamentary powers should be granted to municipal and local authorities, enabling them to embark in enterprises of a trading nature. This suggestion commended itself to the Council, which therefore addressed a memorial to the Home Secretary, asking for the appointment of such a Commission.

* A notice of the exhibition will be found in the *Journal*, vol. xlvii., p. 37, November 25, 1898; and a paper on it, by Mr. E. F. Strange, vol. xlvii., p. 245, February 10, 1899.

XIX.—International Congress on Commercial Education.

The International Congress on Technical Education, the last meeting of which was held in London, in 1897, under the organisation of the Society of Arts, met in Venice, on the 4th of May. The Secretary, Sir Henry Trueman Wood, attended to represent the Society, and read a paper at the Congress on "Commercial Education in England."*

The Congress confined itself on this occasion to the discussion of Commercial Education alone, whereas in former years it dealt principally with Technical Education, The International Congress held last year at Antwerp, dealing with the same subject, though it was attended by a large number of the same delegates, was not under the same organisation as that which arranged for the Congresses previously held in France and in London.

The meeting was well attended by delegates from most of the countries of Europe. The subjects discussed included the general organisation of Commercial Education and its relations with general education, the teaching of modern languages, and the results attained by the attempts which have been made to provide definite trade instruction in schools.

It was decided that no definite resolutions should be passed by the Congress, but the following conclusions were generally arrived at:—That pupils should pass into the schools of commerce from the primary schools, but that no teaching of a commercial character should be introduced into the primary schools; that the pupils leaving the schools of commerce ought to be so trained as to render them immediately useful in commercial life; that great attention ought to be paid to the teaching of modern languages, teachers, as far as possible, employing the language taught, not the language of the pupils, the teaching also being of a commercial character.

The Permanent Committee was asked to prepare a report on the commercial terms used in various languages, with a view to accurate equivalents being provided in the different languages. The committee was also requested to take steps to obtain a number of communications on the existing organisations for commercial instruction in different countries.

* The text of the paper will be found in the following numbers of the *Journal*:—Vol. xlvii. p. 573, May 19th, 1899; vol. xlvii. p. 590, May 26th, 1899; vol. xlvii. p. 624, June 9th, 1899.

With regard to future Congresses, it was resolved that after the Congress in Paris, in 1900, the Congresses should be held at intervals of either two or three years, and some other suggestions were made as to the work of the Permanent Committee in organising future Congresses.

XX.—Chadwick Trust.

The late Sir Edwin Chadwick, who died in 1890, left a considerable sum of money to establish a trust for the purpose of awarding prizes, establishing lectures, and taking other steps for the promotion of sanitary science. The Society of Arts was one of the bodies which were requested to nominate trustees, and on the formation of the trust Sir Douglas Galton was appointed, in 1896, the representative of the Society. His death having caused a vacancy in the representation, the Council appointed Mr. R. Brudenell Carter a member of the trust.

XXI.—Memorial Tablets.

The tablet has been set up, which, as stated in the Report of last year, the Council had decided to place on the house, No. 50, Wimpole-street, where Mrs. Elizabeth Barrett Browning, wife of Robert Browning, the poet, lived for some time, and from which house she was married.

The Council have also decided to erect a tablet on "Bolton House," Windmill-hill, Hampstead, for many years the residence of Joanna Baillie.*

XXII.—Electric Lighting of the Society's Premises.

The premises of the Society of Arts have been lighted by electricity since the year 1883, in which year an engine and dynamo were put down, and the Meeting-room was lighted. The installation was afterwards completed by the purchase of a storage battery, and the lighting was extended to a portion of the offices. The cost of the installation was partly defrayed by contributions made by the following members of the Council:—Sir Frederick Bramwell, Sir Daniel Cooper, Sir Henry Doulton, Sir Edwin Lawrence, Mr. Matthey, Mr. Perkin, and Sir William Preece. The installation has worked quite satisfactorily during the 16 years since it was inaugurated.

The arrangements which were necessary in 1883 to provide the electric light, have since been rendered more or less obsolete by the development in the public supply of electricity, and although the installation has given every satisfaction since it was first laid down, and has worked almost without interruption, the time has now arrived when it can be more economically replaced by a supply to be taken from the street mains. The subject has been under the consideration of a Committee of the Council during the session, and under their supervision the electric lighting arrangements have been thoroughly overhauled, and certain improvements and additions have been made. The work was satisfactorily executed by Messrs. Buchanan and Curwen, electrical engineers, and Mr. Graham Harris kindly undertook its superintendence as a member of the Committee. Arrangements have been made both with the London Electric Supply Corporation, and with the Charing-cross Electric Supply Company for a supply of alternating current in the case of the former, and of direct current in the case of the latter; the object of this arrangement being that either current might be available for experimental purposes. The old plant used for the generation of the current is already in part disposed of, and the price which will be realised for the whole of it will considerably diminish the cost of the alterations.

XXIII.—Conversazione.

The annual Conversazione of the Society was held this year, as it was last, at the Natural History Museum, by permission of the Trustees of the British Museum. This is now the third time on which the building was placed at the disposal of the Society for the purpose, the first occasion having been in 1890.

As on the former occasions, special arrangements had to be made for lighting the Museum. As the building is not intended to be opened in the evening, it is not sufficiently lighted for the purposes of a Conversazione. For this reason only a small portion of the building is available. On the present occasion the only parts of the Museum used were the Central Hall, with its surrounding corridors and galleries, and the Bird Gallery, which occupies a portion of the ground floor of the western wing of the Museum. These galleries were specially lighted with the electric light, the expense of the installation being shared (as it was last

* A complete list of the tablets which had been set up at the time will be found in the Report of the Council for 1895-1896. *Journal*, vol. xliv., p. 681, June 26, 1896. Since that date, a tablet to Sir Harry Vane has been set up in Hampstead. See Council Report, 1897-8. *Journal*, vol. xlvi., p. 700, July 1, 1898.

year) with the Royal Geographical Society, the Royal Colonial Institute, and the Institution of Electrical Engineers—all of which Societies held Conversazioni in the building about the same date.

The usual arrangements for music and refreshments were made. Tickets were issued as on previous occasions to the members of the Society, and additional tickets were sold to members at the price of five shillings each. The Metropolitan District Railway Company were good enough to allow visitors who used the underground railway the free use of their subway leading from the South Kensington railway station into the grounds of the Museum. The total number of visitors attending the conversazione was 1,664.

As on previous occasions the Council have to thank the principal officers of the Museum for their help in carrying out the arrangements for the evening.

XXIV.—New Council.

The Vice-Presidents retiring from office at the expiration of the present year are :—The Attorney-General, Sir Edward Birkbeck, Lord Curzon, Sir Charles Fremantle, and Sir William Roberts-Austen. To fill their places, the Council have placed on the Balloting List the names of the following members :—Sir Steuart Colvin Bayley, Sir Owen Roberts, Mr. Ludwig Mond, Sir W. H. White, and Sir Edwin Lawrence. Sir Steuart Colvin Bayley has just completed his term of office as an Ordinary Member of Council, and Sir Owen Roberts, in accordance with the Bye-laws, resigns the office of Treasurer, which he has held for the period of five years. Mr. Ludwig Mond and Sir William White have not served previously on the Council. Sir Edwin Lawrence held office for some years, but has not been on the Council since 1876.

The retiring members of Council are :—Sir Steuart Colvin Bayley, Mr. M. Carteighe, Mr. Alexander Siemens, and Mr. J. S. Neville. To replace them the Council have nominated Professor Dewar, Mr. J. W. Swan, Sir William Preece, and Sir Edward Nelson. Professor Dewar and Sir William Preece have both served previously on the Council—neither Mr. Swan or Sir Edward Nelson have held office before.

To fill the vacancy in the Treasurership the Council propose the name of the Attorney-General. Sir Richard Webster, as the members well know, has long been a member of the Society's Council, having served a double term of office as Chairman.

XXV.—Obituary.

During the past Session the Society has lost many members who were closely associated with its work. Prominent amongst them is the name of Sir Douglas Galton—a past Chairman of the Council, a member of nearly 50 years' standing, and one who took the very warmest interest in the labours of the Society. The death of Sir William Anderson caused another great loss to the Society. He had been a member since 1883, had served on the Council, and as Treasurer of the Society, and contributed valuable lectures and papers to its proceedings. Sir Francis Dillon Bell, though for the last few years he had taken no part in the Society's work, was at one time a very active member, and served on the Council from 1884 to 1891. Sir Stuart Knill had been a member of the Society for 40 years, and served for four years as Vice-President. Sir John Fowler had not served on the Council, but had been a member of the Society for 50 years. The sad accident which in August last cut short the career of Dr. Hopkinson, deprived the Society of Arts of one of the most distinguished of its scientific members. Sir John Scott, though he took no active part in the Society's proceedings, took a great interest in them, and at one time was a constant attendant. Lord Herschell, who had been a member since 1890, though not very closely associated with the Society, took part in its discussions on some occasions, and presided over one of the meetings of the Indian Section. Dr. Obach will be remembered for the very valuable course of Cantor Lectures on "Gutta-Percha," which he delivered in the autumn of 1897, only a year before his death. Dr. Leitner read several papers of importance before the Indian Section. Mr. Andrew Chadwick, who succeeded his father as auditor to the Society, only held the appointment for six months before his death. Other members of the Society whose names should be mentioned are :—Mr. George Spottiswoode, the eminent printer ; Mr. J. M. Cook, of the well-known firm of tourist agents ; Mr. Jeremiah Head, the distinguished engineer ; Professor Hayter Lewis, a member of 30 years' standing ; Mr. J. J. Colman, who had been a member for 53 years ; Mr. John Phillipson, the well-known carriage builder of Newcastle ; and Captain W. H. Davies, the Managing Director of the Exchange Telegraph Company.

XXVI.—Finance.

The Annual Statement of Receipts and Ex-

penditure was published, in accordance with the Bye-laws, in the *Journal* last week. It shows the revenue of the Society for the financial year ending May 31st last, and the Society's liabilities and assets, its investments, and the Trusts standing in its name. It does not appear that any of the items require special explanation. The statement as a whole may be regarded as thoroughly satisfactory, since it compares favourably with the corresponding statements of recent years.

The sudden death of Mr. Andrew Chadwick, who last year succeeded his father, Mr. J. O. Chadwick, as auditor, caused a vacancy which the Council filled by the appointment of Mr. G. Walter Knox, of the firm of Knox, Cropper, and Company. Mr. Knox is a Past President of the Institute of Chartered Accountants, and has already been associated wlth the Society's work as its examiner in Book-keeping.

[Sir JOHN WOLFE BARRY having been obliged to vacate the chair during the reading of the report, Major-General Sir OWEN TUDOR BURNE presided over the remainder of the proceedings.]

The CHAIRMAN (Sir Owen Tudor Burne) moved the adoption of the report, and said everybody would agree with him that it was a very satisfactory and encouraging one; the Society's financial position had improved and the number of members was maintained. He thought this arose from two causes—first, that all the valuable papers read in that room were despatched in thousands to all parts of the world, and a great many new members joined the Society in consequence. The Society's work, however, was not confined to the reading of papers; it carried out much practical work also. The examinations had been carried on for half a century. The fact that there was a distinct increase in the number of better class candidates showed that the Society had done right in not raising the standard of the examinations, as it was feared would have to be done, in consequence of the numbers of less qualified candidates who came forward in recent years. He fully agreed with the statement in the Report that the surest basis for a good commercial education was a sound general education. The Society had been engaged in very useful work in connection with acetylene generators and the deterioration of paper, and also deserved credit for promoting the Exhibition of Lithographs. It was to be hoped that this exhibition would result in a great development being made in this particular art. The society had lost a long list of distinguished men during the year, and the Council deeply regretted the death of Sir Douglas Galton, and of Sir William Anderson; but they hoped that younger men would come forward to fill up the gaps, and continue the long list of distinguished names associated with the Society.

Surgeon Lieut.-Col. J. INCE, in seconding the adoption of the report, said it was a most satisfactory report, and one felt that the Society of Arts was amongst the most flourishing societies of the country. The work in which the Society was engaged was of great importance and most penetrating, dealing as it did with the ordinary interests of the country, and he looked upon the Society as one of the most useful and most important of the nation. As regards commercial education, he said he must confess that he did not understand what commercial education was, or how the special duties of a clerk in a mercantile office could be taught. The keeping of books and making out of invoices involved a knowledge of arithmetic, and it was impossible for clerks to carry on correspondence with foreign countries unless they knew thoroughly the language of the country. In this respect he thought foreigners were ahead of us, perhaps on account of our occupying an isolated position. As an ordinary member of the Society, he desired to bear his testimony to the satisfactory state of the Society and to the admirable character of the report which had been submitted.

Mr. MARTIN WOOD said he should like again to draw attention to the time fixed for the holding of the annual meeting, he thought that if the meeting were held in the evening, it would be much larger and more representative. It was satisfactory to know that the number of members was kept up, and the Chairman's remarks about the influence of the Indian Section in securing new members from India were exceedingly encouraging. The Chairman had alluded to the success of the examinations, and the efficiency with which they are carried on, and he regarded them as of great importance, as their connection with provincial centres prevented the Society from becoming a purely London institution. He endorsed the Chairman's remarks respecting the losses by death which the Society had sustained, and especially with regard to Sir Douglas Galton. It showed them the need for increasing the personal influence of the Society in order to fill up the gaps. They must remember that things were moving around them, and that unless they were making distinct progress, it it would be equivalent to falling off. He should like to see the list of affiliated institutions extended, and inquired if something could not be done about increasing the number of honorary corresponding members, as it would keep up the Society's international interests.

Mr. W. GREEN suggested that the Conversazione should be held out of doors—say, in the Botanical Gardens. He thought more people would attend the Conversazione if the Council found a fresh place for it. He also suggested that the Council should

arrange some kind of an exhibition every year, similar to those held by the Arts and Crafts, such as exhibitions of wood work, metal work, furniture, and fabrics, as they would do an immense amount of good.

Mr. FRANCIS COBB said, with regard to Mr. Green's suggestion, that it was necessary to provide against bad weather, and that the Council, in selecting a place, always considered that there should be ample room to hold the Conversazione under cover, if necessary. As regards exhibitions, he would remind members that the exhibition of lithographs held last year was at the instance entirely of the Society, and was held at South Kensington because the room that was available in the Society's house was not nearly sufficient for the purpose. The Society had held many exhibitions, and exhibitions of the sort suggested were continually being held.

The CHAIRMAN said the Council were much obliged to Mr. Green for what he had said. His suggestions should receive consideration.

The adoption of the report was then agreed to.

The CHAIRMAN moved a vote of thanks to Sir Henry Trueman Wood, also to Mr. Wheatley, Mr. Room, and the other officers of the Society for the accurate, hearty, and loyal work which they did year after year.

Mr. J. J. VEZEY seconded the vote of thanks, which was carried unanimously.

The SECRETARY, in returning thanks for this expression of confidence in himself and in the other officers of the Society, referred to the recent death of Arthur Cowdroy, who had been a clerk in the Society's employment for thirty years.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Saxe-Coburg and Gotha, K.G.
H.R.H. the Duke of York, K.G.
Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S.
Duke of Abercorn, K.G., C.B.
Captain W. de W. Abney, C.B., F.R.S.
Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.
Lord Belhaven and Stenton.
Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.
Sir Frederick Bramwell, Bart., D.C.L., F.R.S.
Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.
R. Brudenell Carter, F.R.C.S.
Right Hon. Viscount Cross, G.C.B.
Major-General Sir John F. D. Donnelly, K.C.B.
Sir John Evans, K.C.B., F.R.S.
Sir Charles Malcolm Kennedy, K.C.M.G., C.B.
Sir Edwin Lawrence, Bart., M.P.
Sir Villiers Lister, K.C.M.G.
Right Hon. Sir John Lubbock, Bart., M.P., D.C.L., F.R.S.
Ludwig Mond, Ph.D., F.R.S.
Sir Owen Roberts, M.A., D.C.L., F.S.A.
Lord Strathcona & Mount Royal, G.C.M.G., LL.D.
Sir Thomas Sutherland, G.C.M.G., M.P.
Sir William Henry White, K.C.B., LL.D., F.R.S.

ORDINARY MEMBERS OF COUNCIL.

Sir John Wolfe Barry, K.C.B., F.R.S.
Lewis Forman Day
Professor James Dewar, LL.D., F.R.S.
Joseph G. Gordon.
Henry Graham Harris
Sir Edward Nelson, K.C.M.G.
Sir Westby B. Perceval, K.C.M.G.
Sir William Henry Preece, K.C.B., F.R.S.
Sir Walter S. Prideaux.
Joseph Wilson Swan, F.R.S.
William Luson Thomas.
Professor John Millar Thomson, LL. D., F.R.S.

TREASURERS.

The Attorney-General, M.P., G.C.M.G.
B. Francis Cobb.

SECRETARY.

Sir Henry Trueman Wood, M.A.

On the motion of the CHAIRMAN, a vote of thanks to the scrutineers was carried unanimously.

Sir GEORGE BIRDWOOD proposed a vote of thanks to the Chairman of Council, Sir John Wolfe Barry. He said the Society had been very fortunate in its Chairmen, as the first men of the Society had always served the Society with the greatest benefit in all its interests, and it was no exaggeration to say that Sir John Wolfe Barry's services had been equal to those of any of his predecessors. He looked forward to the prospect of his remaining with them as Chairman for another year.

The resolution was seconded by Mr. FRANCIS COBB, and carried unanimously.

On the motion of Mr. W. LUSON THOMAS, seconded by Surgeon Lieut.-Col. J. INCE, a vote of thanks was passed to Major-General Sir Owen Tudor Burne for his services in the chair.

The CHAIRMAN acknowledged the vote of thanks; and the meeting then adjourned.

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FRIDAY, JULY 7, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS.

The results of the Examinations held at the end of last March have been published.

Copies for gratuitous distribution to each candidate who attended the examination have been sent to each centre. Additional copies can be obtained, price 6d. each.

The dates for the Examinations in 1900 will be Monday, Tuesday, Wednesday, and Thursday, March 26th, 27th, 28th, and 29th.

Proceedings of the Society.

CANTOR LECTURES.

BACTERIAL PURIFICATION OF SEWAGE.

By Dr. Samuel Rideal, F.I.C.

Lecture I.—Delivered January 16, 1899.

The primitive mode of disposal of effete matters consisted almost entirely in the very effective method which is still in use in dealing with the dead, namely, a committal to earth. Deuteronomy xxiii., 12, 13, enjoins that all excreta shall be covered with earth, following the natural instinct of many animals. It will be noticed that this instinctive effort to cover the dejecta is most prominent in the carnivora, in which the matters are most nitrogenous, and therefore more highly offensive, whereas in the herbivora, no such natural propensity is observed. In the case of pastural populations depending on springs and wells, water was too scarce and valuable to be purposely polluted. Those residing on the banks of rivers also refrained, to a great extent, from casting their refuse into the streams used for their bathing and drinking, and, having access generally to an ample amount of open and porous soil, employed, what we may call, the earth system. As soon as a portion of the population, for protection or convenience, became aggregated into settlements, it was early found necessary to set aside certain special places for the reception of refuse, hence the midden heaps that have been widely discovered in the neighbourhood of aboriginal villages. After a time for human excreta ditches or trenches were dug, from which the products of decomposition either sank into the surrounding soil, or found an outlet to some watercourse. In many cases trenches were at length filled in with earth, over which a rank vegetation grew, and the soil became gradually purified, a plan which is still followed in the case of temporary camps and in eastern villages. At a later stage, when the progress of civilisation necessitated the use, for washing and cooking, of a larger quantity of water, isolated inhabitants found it difficult to dispose of the liquids, therefore great pits were dug to receive them, and to keep the rain out were roofed over with beams and earth. At a still later period these excavations were lined with brick, arched over, and connected wtih the houses by brick or flagstone drains. No cement, as a rule, was used in the construction, as it was found that if the sewage sank into the earth less frequent emptying was required. Moreover, if the receptacle or "cesspool" were made air- and water-tight by cement, it was necessary to provide a vent for the large quantity of gas that was generated in the decompositions. The author can record a case where a cemented cesspool in the north of England regurgitated a large quantity of sewage into the cellars of the house, although the pit had been recently erected, and was by no means full. In other cases unventilated cesspools have filled the basements of dwellings with sewer gas.

For houses in isolated positions the cesspool, till lately, was the only available means of sewage disposal, and architects and others spent considerable time and skill upon the design in the early Victorian period, when sanitary progress first drew attention to its importance. I give the following as an example of its successful use, which is interesting on account of its being antecedent both to the French "Automatic Scavenger," to be described in a subsequent lecture, and to the modern "Septic Tank":—

In 1858, a large school in Derbyshire, situate on the top of a lofty hill, surrounded by

its own land, but at a distance of two miles from a small river which ran through other property, had to provide for the sewage of 250 to 300 persons, and the drainage from a farm. The water supply was adequate for ordinary needs, but not sufficient for water carriage of the sewage. A very large cemented brick pit was constructed underground, and arched over, at the back of the buildings and 200 yards from them. Into this the whole sewage passed continuously. When the floating gauge indicated that the pit was full the whole contents were pumped out from a point near the bottom, and discharged by pipes over cultivated slopes, finally filtering through a gravel and chalk soil into a moderate-sized reservoir in a clayey valley at the foot of the hill, where it mixed with water derived from springs and a rivulet. The mixed water was clear and bright, except for an occasional turbidity from the clay. At the periods of emptying no nuisance occurred; sometimes a faint, earthy odour was noticed when the wind was in the direction.

But in towns, the crowding together of cesspools renders a large area of soil waterlogged with black and fetid matter, which undergoes little or no oxidation; while the periodical clearing out may be an offensive, and sometimes dangerous, process. At Hampstead, for instance, in a sandy soil, cesspools were formerly almost universal, and were thickly distributed, so that the earth, and often the basements, were heavily infiltrated; it is needless to say that most of them have now been removed. A striking example of the pollution of a deep well by leaky cesspools occurred at Liverpool in 1872. The Dudlow Lane Well, in the new red sandstone, 443 ft. deep, by continuous pumping had dried up all the private wells in the neighbourhood; these were afterwards used as cesspools. As a result, the water in the deep well became polluted, and in a few years after its construction it had to be closed. On diverting the drainage from the cesspools the water was so improved that it was considered safe to resume its use.

For these reasons it became necessary to organise a regular system of drainage by sewers. But the difficulty was still not overcome. In the ramifications of these canals a good deal of leakage occurred. The construction of traps to intercept the gases, and of ventilators to remove them, was for a long time, and in many parts still continues to be, very imperfect; in fact, the ventilation question is only now showing signs of solution. The greatest difficulty, however, arose when an outlet had to be found for the immense volume of the sewage of modern towns. To discharge it untreated into rivers, unless of many times the capacity of the sewage and well oxygenated, converted the stream itself into an open sewer. It will be in the memory of many Londoners how black and offensive the Thames was formerly between the bridges, and even in 1894 the Seine near Paris was so polluted that Dr. Billings observed, "Bubbles of gas from the putrefying slime at the bottom escaped from the dark surface, and no fish could live in it," affording an example of a bacterial process working naturally, but imperfectly and under improper conditions. The Irwell, at Manchester, in 1892, was practically sewage, as the following analysis by Hepworth Collins (Transactions Sanitary Institute, 1892, p. 196) will show:—Total solids, 160·6; consisting of organic 59·6, mineral 101·0, suspended solids 29·6, ammonia free and albuminoid 0·900, chlorine 11·9; oxygen absorbed 4·90.

Effects of Dilution.

On the other hand, with conditions that are favourable, the purifying action of rivers is known to be very great. Towns on the banks of rivers of considerable width, and having a fairly constant volume and velocity during all seasons, have discharged their raw sewage into the stream for many years, and investigation has proved that a few miles below the outlet of the sewers there is little or no trace of pollution.

Many chemists believed that sedimentation was the main cause of any self-purification in river water. But any extensive improvement by mere sedimentation would be on the wrong lines, and should not be permitted, as it would result in a filling up of the river bed and formation of dirt banks which become foul. If, on the other hand, suspended organic matter is slowly removed to the river bed and is there attacked, in the absence of air and light, by the organisms naturally fitted to the purpose, the products will dissolve and become available for the water bacteria in the river. In a paper read at the British Association at Bristol in 1898 on "Standards of Purity for Sewage Effluents," I discussed the conditions for safe discharge into a flowing stream, pointing out that "methods had been found which, by natural agencies, allowed us to carry the purification to a rational and harmless stage, when such factors as time, light, volume of oxygen, and various life of a river will be more than sufficient to deal with the effluent."

Pettenkofer, from investigations on the river Isar, at Munich, has concluded that if the sewage never amounts to more than 1-15th, or 6·7 per cent. of the river water, and the velocity of the latter is at least equal to that of the former, the raw sewage may be poured into the river without causing pollution.

In America, from the results of actual observations on rivers, under the direction of the Massachusetts Board of Health, Rudolph Hering fixes a limit to the amount of free ammonia permissible in a stream, and finds that if the flow of a stream is less than 2½ cubic feet per second per 1,000 persons (or one gallon per minute per person), "an offence is almost sure to arise," but when the flow is greater than 7 cubic feet per second per 1,000 persons, then safety is assured. "In other words, when the free ammonia is greater than 0·12 parts per 100,000, the conditions are probably objectionable." These limits correspond to about 50 volumes of river water to average sewage in this country. Mr. Stearns, the engineer to the Massachusetts Board, concludes that if the average amounts to more than 1-40th, or 2·5 per cent. of the river water, it cannot he discharged into the river in its raw state; if it amounts to less than 1-40th, and more than 1-130th, it is doubtful; if less than 1-130th, it may be admitted without any doubt in its raw state into the river. These conclusions are, of course, empirical, and have not been generally accepted; they would be greatly affected by the amount of solid matter present in the discharge. It must be remembered that the sewage in America is much more dilute than in this country, that the rivers have greater volume, and that the limit is much higher than we have found necessary in England.

It is possible, however, to form an estimate as to the amount of sewage which can be dealt with by a flowing stream, if one remembers that the bacteria, always naturally abundant in river water, are able by the aid of the oxygen dissolved from the air to consume more or less rapidly the organic matter. It is evident that the volume of the sewage and the oxygen required by the organic matter in it as measured by permanganate—*i.e.*, the "oxygen consumed"—should bear some relation to the flow of the river and its aeration. But, in addition to this, it is also desirable to take into account the amount of available oxygen as nitrate and nitrite, since it has been proved that, always with the help of bacteria, the oxygen of nitrates and nitrites is available or the burning up of organic matter.

From these factors the following formulæ may be deduced. Where X is the flow of the stream, O the amount of dissolved oxygen, S the volume of effluent, M the "oxygen consumed" by the latter, N the available oxygen as nitrate and nitrite, C the ratio between the amount of oxygen in the stream and that which is required to oxidise the organic matter in the effluent, then the equivalent will be—

$$XO = C\,(M - N)\,S.$$

Where the sewage is fresh, and no nitrates have been formed—

$$XO = C\,M\,S.$$

If N be less than M, $M - N =$ the deficit of oxygen in the effluent, requiring to be supplemented by the free oxygen in the river: such an effluent will throw a burden on the river, and cannot be considered in a satisfactory state, and it will be a question of volume and other circumstances whether it can be permitted to be discharged at all. This may be determined by the consideration that if the available oxygen of the river, XO, be greater than the demand $(M - N)\,S$, there will be a chance of the stream dealing with the inflowing liquid, but if the reverse be the case, foulness will necessarily accrue.

In the favourable cases where bacteria and algæ are active, and the oxygen of the river is able, by their help, to deal rapidly with the incoming residues, the minimum ratio between the volume of the stream and the volume of effluent that could be allowed to be discharged into it would be indicated by the value of C in the above equation, which would also approximately denote how far the population might increase before the proportion could be seriously disturbed. The minimum figure will be reduced by the nitrites or nitrates of the river water itself, or the free oxygen which may be present in the effluent. River water often contains about 90 per cent. of its nitrogen in the oxidized form, and when saturated, holds about 700 c.c., or, approximately, one gramme of dissolved free oxygen per 100 litres. These materials for purification require to be supplemented by the agency of the natural bacteria, which, with the almost unlimited exposure and admixture in a flowing river, we may assume as certain to be present. Hence, in theory, comparatively few volumes of a river water will supply the requisite oxygen, which explains the well-known fact that in the lower reaches of a river the dissolved impurity is only a fraction of what has entered in its upper course. Dupré states that, on an average, dilution with thirty

volumes of fully-aerated river water prevents sewage from fouling, and ultimately purifies it. Even a less proportion, in my experience, has been effectual.

For one town then, on the banks of a large river, or even several towns, if they are sufficiently separated to allow natural recovery and aeration of the stream, the elementary method of discharging the untreated sewage into the water direct has been successful in the past, with the proviso usually required that by screening, sedimentation or precipitation, the suspended solids should be prevented from forming mud-banks and deposits of black sludge on the river bed.

Exeter, for example, a town which is now interesting from its association with the septic tank system, has also the historical position of being the first city to be sewered, and to discharge the combined sewage, untreated, into a river. As the volume of the Exe is about forty times that of the sewage, at the recent inquiries no chemical evidence of pollution a few miles below the city was obtainable.

But in countries thickly populated there is no such opportunity for the recovery of the river. Given even twenty-four hours for the completion of the natural process, the river would arrive at the next town denuded of its oxygen and in an unfit state for the reception of more sewage. The result has been such a condition as I have already mentioned in connection with the Seine and Irwell. Hence it is, as a rule, necessary for the sewage to be prepared before it can be allowed to be discharged, and the methods for so doing constitute our present subject.

It will be noticed that the characteristics of sewage are the converse of a pure running stream; and this is true, not only from the chemical point of view, but also when one studies the normal flora and life in the two. In a well oxygenated river the water bacteria are mainly aerobic, and carrying out their life-work of oxidation of the nitrogenous and carbon compounds presented to them. In a sewage, on the other hand, dissolved oxygen is usually absent, or, if present, soon disappears on standing, so that the organisms capable of living in this environment must perform their life-work without free oxygen. The water bacteria have been studied for many years, and those commonly occurring in river water are well known. Sewage organisms have only attracted attention during the last few years, and bacteriologists are now engaged in identifying the flora of different sewages, with especial reference to the changes which they effect in the chemical constitution of their environment. It would seem, therefore, from the outset, that if these sewage organisms have any useful part to play, similar to that which they naturally do, in any modern system of sewage disposal admixture with river water, in which an entirely different set of organisms live, or exposure to the air, must be avoided. We have seen that in the two earlier methods of disposal, viz., committal to earth and the cesspool, absence of light and air were obvious conditions obtaining in both; and now, with our modern knowledge, we can say that these two conditions were favourable to the life-work of the organisms concerned in the destruction of the organic matter. With the introductiou of the water-carriage system a departure from these conditions was made, and the difficulties which have since arisen can, in most cases, be attributed to a violation of one or other or both of them. When sewage is discharged untreated into a river, as we have just seen, sewage conditions or river conditions will exist after admixture, according to the ratio of the admixture. As sewage conditions involve absence of light and air, they will continue at the bottom of the river unnoticed if sufficient river water is present to mask these initial changes which must take place. If the river be a small one the sewage conditions may predominate, and constitute a nuisance which is all the more marked because the changes involved take place unobserved (out of the air) and unseen (in the dark).

It will be out of the scope of the present lectures to enumerate the characteristics of any of the water organisms concerned in the chemical changes taking place in a running stream. It is evident, however, that they normally can deal with the food supply presented to them, and the whole of the life of the stream is determined by their activity. At the present time it is becoming daily more possible to detect whether a river water has a flora which in any way departs from the normal, so that evidence of sewage pollution may now be ascertained by a careful examination of the types of water organisms present. Thus, for example, recent work on the organisms present in London sewage by Dr. Houston, for Dr. Clowes, the chemist of the London County Council, has established the following facts:—

Bacillus fluorescens liquefaciens and *B. fluorescens non-liquefaciens*, were generally, but not always, discovered. The bacteria causing fluorescence do not seem to be so

prevalent in the London sewage as in that from other sources. Both the above are frequent in natural waters.

Proteus.—The species most abundant was not the typical Proteus vulgaris, but liquefying and gas-forming protean forms were very numerous.

B. coli communis is constantly present in very great numbers. This organism is absent, at all events in any numbers, from pure waters. Varieties of the Coli group are also abundant.

Of spore-bearing bacteria, the spores of *B. subtilis*, *megaterium*, *mycoides*, and *mesentericus* were frequently found. These are chiefly notable for their great vitality and resistant powers, but are also met with in natural waters.

B. enteritidis sporogenes (Klein), was constantly present: it is believed to be causally related to diarrhœa. Cultivations of it are extremely virulent.

Unfortunately, many of the organisms enumerated also occur in river waters which presumably are pure, so that their value for diagnosing the presence of sewage in water is only of slight value. Dr. Houston, however, points out that the *B. enteritidis* of Klein is so characteristic of sewage that its presence in a river water may be regarded as a sure sign of the addition of sewage. This organism, like other typical sewage organisms, thrives in the absence of air, and is recognised by its coagulating effect upon the organic solids of milk, a property which the ordinary water bacteria lack.

Seaside towns usually discharge their sewage on the foreshore near low-water mark, but a great portion is returned by the tides, and the serious nuisance often occasioned has led to agitation against this practice. Sea water is not a satisfactory medium for the purification of sewage, partly because it contains a comparatively small number of water bacteria, but mainly because the tidal disturbances prevent sedimentation of the suspended organic matter, which allows, as we have seen, the organisms which live in the absence of air and light to do their necessary work.

A partial return to earth-disposal was seen in the adoption of irrigation, but the experience gained on sewage farms, and the study of nitrification by bacteriologists, have shown that, in the case of land treatment, different soils have very varying efficiencies. Thus the earlier experiments seemed to show that the "cleansing" power of a soil was determined entirely by its physical condition, porosity, freedom from clogging, water-retaining power, &c.; whereas at the present time we know that the composition of the soil and its bacterial condition modify the results. In some soils nitrification either does not take place at all, or goes on with extreme difficulty. Crude sewage discharged direct on land rapidly coats it with a felted layer of black decomposing matter, which hinders the access of oxygen, chokes the plants, and soon creates a nuisance, unless the soil is exceptionally sandy or porous as in the neighbourhood of Berlin.

Great diversity of opinion existed as to the best vegetation for a sewage farm. Root crops and Italian rye grass found favour on some farms, while osier beds met with success on others, and owed a portion of their usefulness to their acting as a mechanical strainer. At Sutton, in recent years, peppermint has been found profitable, whilst sunflowers have been advocated as a suitable quick-growing crop. But the results were above all dependent on the soil. Thus Dr. Frankland, in 1870, speaking of a sewage farm at Barking, remarks on the slowness of nitrification, while with regard to a loam from Dursley, in Gloucestershire, he found that it surpassed all others experimented on in its power of purifying sewage, as it had a cleansing power of nearly 100,000 gallons per acre per day. We now know that the presence of carbonate of lime, or of gypsum, is favourable to the growth of nitrifying organisms, and the Dursley soil contained 8·1 per cent. of $CaCO_3$, while that at Barking had less than 2 per cent.

I had lately to determine the merits of alternative sites for a sewage farm in the Midlands. The average amounts of water in the three soils were 6·75, 1·90, and 3·05 per cent., while their comparative nitrifying power, as shown by their action on dilute urine, was 17, 50, and 36, which is almost exactly in inverse ratio to the amount of moisture, showing the powerful adverse retarding influence of a water-logged soil.

The unsatisfactory results on sewage farms led to the opinion that the sewage should be first prepared, and a "combined system" of treatment was prescribed almost universally by the Local Government Board. The details of different processes of screening, filtering, sedimentation, and the use of precipitants are beyond the scope of these lectures. It is sufficient to say that the removal of suspended matters, and a greater or less reduction of

those dissolved, was attained, it was then considered, mainly by physical or chemical means.

One cannot, however, omit to draw attention to the almost universal adoption in this country of different methods of chemical precipitation after the River Pollution Commissioners issued their report. This was in great measure due to their finding that chemical precipitation effected the removal of the greater part of the suspended organic matter, and of some of the dissolved organic matter. This result was seized upon as a practical method of dealing with the sewage problem, as the effluent after such chemical precipitation was obviously less foul than the raw sewage. It was forgotten almost entirely, however, that the Commissioners, in the same report, distinctly state that just as good results could be obtained by upward filtration; in other words, if the sewage were allowed its conditions of absence of air and light, it could be brought into solution and towards purity. It was also not recognised at that time, that chemical precipitation, while removing the suspended polluting matter, would also remove the concomitant bacteria from their sphere of usual action, and thus prevent any desirable changes naturally brought about by them. Likewise also, it was not realised that heavy doses of chemicals were likely to be inimical to these beneficent bacteria to such an extent that they might be killed or their work arrested.

The conclusion of the Massachusetts Board, in their report of 1890 (p. 788), showed that "it is quite impossible to obtain effluents by chemical precipitation which will compare in organic purity with those obtained by intermittent filtration through sand." It would thus seem that for nearly 20 years the almost universal practice of chemical precipitation had been wrong in principle, and that the example set by Merthyr Tydvil in 1871 should have been followed. This town then contained 50,000 inhabitants, and the sewage, after treatment with lime, was subjected to intermittent filtration through 20 acres of porous soil drained from 5 to 7 feet deep, under the superintendence of Mr. Bailey Denton. From the analyses made by Sir E. Frankland in 1871-2, I have prepared the following averages, adding also his "proposed standards of purity."

	Dissolved Solids.	Organic Carbon.	Organic N.	NH_3	N as Nitrates and Nitrites.	Total combined N.	Cl.	Suspended Solids.	
								Mineral.	Organic.
"Proposed Standards"	Unlimited	2·0	0·3	Unlimited	Unlimited	Unlimited	Unlimited	3·0	1·0
Sewage after liming	52·0	2·44	0·9	2·7	·017	3·18	5·98	11·8	21·6
Filtrate	33·2	0·14	0·03	·063	·273	·348	2·74	trace	trace
Subsoil water......	19·4	·106	·011	·004	·061	·075	0·9	—	—

The figures show that the sewage has undergone dilution with more than its volume of subsoil water, and probably with some rain, as the mean dissolved solids of the sewage and subsoil water are about the same as those in the effluent, while the chlorine in the effluent is less than half that in the sewage. But even with this allowance, the result justifies Frankland's pronouncement that "the effluent water on all occasions was purified to an extent much beyond that required by the standards of pollution suggested by us as those below which refuse liquids should not be permitted to enter rivers." The analyses are of further interest at the present time, as we can see from them that:—

The reduction of the total nitrogen, by about 75 per cent. (making allowance for dilution), is not accounted for by the somewhat meagre production of nitrate and nitrite.

Since the sewage "gradually sank into the soil as it flowed," this improvement can only be partially due to volatilisation of free ammonia, of which soils, as is known, are very retentive.

The large reduction in organic nitrogen was doubtlessly occasioned in part, at first, by its absorption by the soil, but as the analyses extended over nearly a year and half, and the later ones showed the same changes, this mechanical absorptive action must be excluded as an unimportant item.

The explanation is to be found in the life of the bacteria growing in the soil, and acting by various processes in which a large quantity of free nitrogen and lower oxides of nitrogen is generated from both ammonia and organic matter, and evolved as gas. In fact, the whole process, instead of being, as it was considered at the time, partly mechanical and partly chemical, was in its essence bacteriological.

Even under favourable conditions the results of irrigation are dependent upon the degree of skill with which the work is directed. When sewage is poured over clay-land which cracks in dry weather to the depth of the underground drains, it escapes in such weather almost immediately from the field in an imperfectly purified condition. When allowed to flow over an uneven surface, or without a regulated flow, it is certain to form stagnant pools in which the plants are injured, or only rank weeds are produced. All the uncertain conditions with which a farmer has to deal are complicated by the stream of sewage. Although the opposition almost invariably encountered in the establishment of sewage farms, on account of the nuisance often occasioned and the expected injury to health, does not seem to be well-founded where the management is efficient, the hope of return of capital has had in nearly all cases to be abandoned, on account of the initial cost of the necessary land and the poor return from the crops grown. For these reasons the insistance of the Local Government Board on a final treatment by land has met with very severe comment, especially since it has been shown to be practicable by bacterial agencies to accomplish the object with less attention, space and cost, and with more regularity. At the same time all these rudimentary methods which have been described have depended for the final stage of purification on the assistance of a river, or of porous land.

Miscellaneous.

*POTTERY AS A HISTORICAL DOCUMENT.**

When I was invited to open this Exhibition, I was asked to deliver an address on the history of pottery. Although I had at hand, to help me, the late Professor Middleton's admirable article on "Pottery" in the *Encyclopædia Britannica*, and Messrs. Sparkes and Sandys recently published volume on *Potters: their Arts and Crafts*—that was rather an unmanageable subject to deal with in about twenty minutes, and what I have determined to do is, before dealing with the present position and future prospects of the potting industry in Staffordshire, to say a few words on the overwhelming magnitude of the debt of the whole civilised world to the potter's craft, in providing us with the very earliest, the most continuous, the fullest, and the most authentic, of the contemporary records that have come down to us from "the dark, backward, and abysm of time" of all the historical states of Antiquity. Pottery was the oldest and most enduring of the arts, and with basket-making and weaving, marks in every country the first dawnings of civilisation. All the initial civilisations have arisen in great river basins, such as the basins of the Ganges, the Tigris and Euphrates, and the Nile; and this has been due not only to the supply of water for irrigation, but of clay for potting.

* Address delivered by Sir George Birdwood in opening the Industrial Exhibition at Clough Hall, near Stoke-on-Trent, Thursday, 22nd June.

CHALDÆA.

Chaldæa, later known as Babylonia, was architecturally and artistically, if not also commercially and politically, entirely a creation of the potter. Juvenal (x. 171) says that "Babylon was a city protected by potters;" Ovid (Met. iv., 58), that "Semiramis raised up the proud walls of Babylon with baked bricks;" and Ezekiel (xxiii. 14), that "men [were] pourtrayed upon the walls of the palaces of Babylon, the images of the Chaldeans pourtrayed with vermilion." The modern excavations of Layard at Nineveh and Babylon, and of Dieulafoy at Susa, have confirmed these literary references to the immemorial tradition of the prodigious production of bricks and other fictile wares in Babylonia, and of the perfection there attained in the decoration of public buildings with tiles, and large slabs graven, or incrusted, or moulded with illustrations of current events, and painted over in enamel with the most brilliant colours. But the most remarkable creations of the potters' craft in the valley of the Tigris and Euphrates are the tablets, inscribed in cuneiform characters with the chronicles of the rulers of Assyria and Babylonia, and with the religious conceptions and beliefs, and the memoranda of the daily lives and business transactions of their people. The record tablets of Assyria provide an unbroken and minutely detailed chronicle of the declining decades of the Old Empire, and of the whole period of the New Empire to its confused close, that is from B.C. 900 to 667. For Babylonia the chronicle texts reach continuously back from the 6th century B.C., to beyond King Khammarubi, who first brought all Babylonia under one rule, B.C. 2376-33. But casual tablets carry us far beyond the latter date. A cylinder of Nabonidas, B.C. 556, assigns to a predecessor, Naraim Sin, a date of 3255 years before his own, *i.e.*, the date of B.C. 3755. At first this abysmal date was received with natural scepticism; but some years ago an American exploring

expedition unearthed at Nippur, at a depth of 30 feet below the surface of the soil, the platform of a temple all the bricks of which were inscribed with the names of Naraim Sin and his father Sargon I; while below this platform they excavated the *débris* of older buildings, down to the depth of another 30 feet; the inference being that the oldest buildings constructed on the spot cannot be assigned a later date than B.C. 7000. At all events the pottery of Babylonia affords conclusive evidence of the actual beginnings of art and artistic culture in Mesopotamia centuries anterior to B.C. 4000. But not only the whole chronicle history, but the whole religious literature of the Babylonians has come down to us indelibly scriptured on these imperishable burnt tablets, of which almost every city, the ruins of which have so far been explored, appears to have possessed an edition of its own.

EGYPT.

Pottery in Egypt goes back to as primæval a period as in Chaldæa, and at a very early date reached the highest perfection in the form of unglazed bricks, unglazed and glazed tiles, glazed scarabs, and other images of the gods, richly-enamelled plaques, and painted vases. The pyramid builders of the IV. Egyptian Dynasty, B.C. 3751-3998, were the contemporaries of Sargon I. and Naraim Sin in Chaldæa. Very beautiful also are some of the doorways, built up of enamelled tiles, of the tombs and temples of the XIX. Egyptian Dynasty, in the 13th and 14th centuries B.C.; and very valuable in many ways was the Egyptian fashion of representing in their vase paintings every type of the human races known to them, with the details of the clothing and jewelry worn by them, and of the arms they carried. In this respect we are indeed under as deep an obligation to the Egyptian potter, as to the Assyrian sculptors of the so-called "Nineveh Marbles." But the history of Egypt was never intentionally recorded in pottery, as was that of Babylonia; and we only become dependent on pottery for Egyptian history where the stone monuments of the country have disappeared, as in the Delta; and the only light we obtain from the vast mounds of broken tiles and vases that exist there is casual and disconnected. The earlier Egyptian dynasties ruled from capitals without the Delta, from Memphis (just at its apex) to Elephantine, throughout which prolonged tract the river Nile is huddled in on either side by rocky hills, precluding therefore any temptation to destroy the earlier monuments for the construction of later buildings. On the other hand, the XXVI. Dynasty, founded by Psammetichus I., in the 7th century B.C., had its capital at Sais, well within the Delta, where nearly all the stone monuments set up by Psammetichus I., and Pharaoh Necho, and Pharaoh Hophra, and their successors, have been used as quarries for providing the Arab devastators of Egypt with materials for building the cities of Rosetta, Damietta, and Cairo. On the other hand, the Delta being rich in clay, it became from a very early period a great centre and market of the potters' industry; and the site of the Greek colony founded at Naucratis during the reign of Psammetichus I., has been identified, and its internal economy, and external trade, and its whole history traced, by means of the painted and lettered potsherds found among its ruins. This city, so rich in the remains of the fictile arts and crafts of the Greeks, is also deeply interesting to all Englishmen, as the first fruit of the free trade policy, initiated by Psammetichus I., of throwing Egypt open to foreign settlers. The similar policy adopted, in the same 7th century B.C., by Nebuchadnezzar II., gave its first great impulse to the sea-borne traffick of Babylonia with Persia, Arabia, Western India, and the East Coast of Africa: and this enlarged commercial intercourse between the countries of the Indian Ocean, gradually joining hands, across the isthmus of Suez, with the active mercantile enterprise pursued by the Greeks, in succession to the Phœnicians, along the coasts of the countries of the Mediterranean sea, at last that great historical trade was established between Southern Europe and Southern Asia, which flourished almost uninterruptedly from the 7th century B.C., to the rise of the devastating Saracenic power in the 7th century A.D.

GREECE.

As the "go-a-ducking Phœnicians" were the first intermediaries in the trafficking between the peoples of the Mediterranean countries, and were later supplanted in this coasting trade by the "cogging Greeks," the latter were until very recently supposed to have received the first inspiration of their arts from Egypt and Anterior Asia: and one of the greatest services rendered by the potter to the history of art has been to prove, within the present generation, that while Hellenic art certainly received certain impulses, and a variety of decorative motives, from both Mesopotamia and Egypt, these existed in Greece, centuries before the Dorian invasion [*circa* B.C. 1100], a highly developed indigenous art, which, in the traditions it provided of the close study of nature, and of refined technical methods, laid the solid foundations of the Hellenic art of Greece, as it began to assert its independent individuality between the 8th and 7th centuries, and reached its perfection in the 5th and 4th centuries B.C.; and that the influence of this pre-Hellenic art of Greece not only dominated the immigrant Hellenes, but asserted its influence over Europe, far beyond the limits of Greece, to the very shores of the Baltic Sea and the German Ocean.

In 1868, Schlieman made his marvellous discoveries in the prehistoric mound at Hissarlik in the Troad, and in the prehistoric ruins at and about Mycenæ in the Argolid. These discoveries included not only figulines, but all sorts of objects of art, of which the most sensational were of course the jewelry of elaborately wrought gold. Schlieman thought he had broken into the Treasuries of Priam and Atreus,

and laid bare the very bones of Agamemnon. But he had done something much more important in the elucidation of the history of European art, for his discoveries—confirmed as they were by the discovery of similar figulines at Ialysus in Rhodes, in the islands of Thera, Naxos, and Paros, and throughout the Cyclades, in Cyprus, in the Mycenæan cemetery at Thebes, in the Temple of Apollo at Delphi, in the neighbourhood of Athens, and, sporadically, over all Greece—demonstrated that an indigenous civilisation, capable of the highest artistic achievements, had preceded the primitive Hellenic civilisation of Greece, and that in its beginnings it must have extended back to the very verge of the neolithic night of Europe; and that after it was suddenly blotted out by the Dorian invasion of Greece, *circa* B.C. 1100, the tradition of it still remained a living artistic force in Greece, and irradiated the stories of the *Iliad* and the *Odyssey* with their after-glow. This Mycenæan or, as it is now called, Ægean art, culminated in the 15th century B.C., and was therefore contemporary with the later Pharaohs of the XVIII. and the earlier Pharaohs of the XIX. Egyptian Dynasties. Its ornamentation is characteristically marine, and some of its conventional motives were conveyed, in the course of the prehistoric amber trade of Europe, into the countries of the Baltic Sea and German Ocean, where, centuries afterwards, they reappeared as "The Three Legs of Man," and "The Celtic Knot." The jewelry is, as already said, wrought with the utmost skill, while the pottery, in the best baked ware, is found fully developed in colour, glaze, and varnish. In the *Iliad* and *Odyssey* many of the lesser objects of industrial art are mentioned as the work of the Phœnicians; but the nobler ones are ascribed to the gods, that is to the forgotten and mythologised artists and artificers of "Mycenæ the Golden [πολύχρυσος]." The *Iliad* and the *Odyssey* were, indeed, the only links between the Ægean art of prehistoric Greece and the Hellenic art of Phidias and Praxiteles, until the recent excavations of the Acropolis, below the *débris* of the buildings re-erected on the sacred hill after the destruction of Athens by the Persians, B.C. 520, led to the discovery of the immense collections of the remains of primitive Hellenic art that had lain there buried and undisturbed for over two millenniums. After this date there was a rapid evolution of Hellenic art, the chronology of which, from first to last, is always to be most clearly and fully traced in the fictile wares of the Greeks, that is in their painted vases, which, including many of the so-called Etruscan vases, also afford us the most complete descriptions we possess of the costume, manners and customs, and whole social life, and also of the religion and mythology of the Greeks.

Rome.

Glancing at the native pottery of Italy, in so far as it throws any light on the ancient history of that country, I would briefly refer to the excavations of the terramarine village of Castellazzo di Fontenallato, where a rustic crematorium was found, having beside it a platform with a number of urns, containing the ashes of the dead, arranged on it in a four-square order, with dividing cross gangways, after the ground-plan of the villages of primitive Italian, and all antique cities. This is one of the most pathetic and suggestive relics of primitive Europe. I will only add, under this head that, the remains of Roman pottery indicate to us more exactly than any of the literary records of even so comparatively late a date, what were the real limits of the Roman Empire, so far as its intimate civilisation spread beyond the boundaries of Italy.

Britain.

There was a vigorous native art in Britain before the Roman conquest of these remote and fog-banked islands, an art of the nature-loving Ægean type, and undoubtedly indirectly inspired by the Ægean art of Mycenæ; but such was the predominant force of the Roman invasion on southern and south-western Great Britain, that our indigenous rustic pottery was at once replaced by the so-called Samian ware, the fashion of which was imported, as Pliny tells us, from the island of Samos into Etruria, and was afterwards imported by the Romans into whatever still savage countries they carried their ever-victorious standard. But our native industrial arts found a timely and safe refuge in Scotland, and Ireland, where the practice of them slowly developed those distinctive Celtic arts, which as Rome declined and at last fell, re-issued from their reinvigorating retreats, and, as modified by Byzantine [including so-called Saracenic] art, flourished for centuries over all Western and Northern Europe, and even reacted on the arts of Byzantium.

The Future of British Pottery.

The advances made in British pottery during the past 150 years has been remarkable, and the improvement in its artistic quality since the Great Exhibition of 1851 has been truly wonderful. That exhibition gave an extraordinary impulse to all the artistic industries of the United Kingdom, excepting jewelry; and in none of these industries have the resulting effects been so beneficial and momentous as in pottery; the redeeming grace of our pottery, in all its numberless local variations, being the distinctively British love of nature, and of the study of nature in the harmonious combination of decorative forms and colouring, which can nowhere be artificially combined more felicitously than in pottery. Never was the pottery industry of this country more healthful and active than at the present time, and there is before it an immediate future of unbounded prosperity. Its artistic superiority, in its simple naturalness and dexterous *technique*, over the pottery of all other European manufacturing countries, was being everywhere recognised, and the demand for all classes of British pottery was every

year increasing in the United States, and the other English-speaking nations of the New World and the Old. Apart from this, pottery was coming into growing demand for many purposes to which it had never before been generally applied in this country. The National Liberal Club, in Whitehall-place, London, was an illustration of the pleasing effects to be obtained by covering the walls of ordinary living-rooms and house passages with enamelled tiles. In the Brompton-road, London, a house is now being completed, the whole front of which is covered with enamelled tiles of deep-toned brown. Nothing can be more magical than the play of the slanting shafts of the light of sunrise and sunset on these tiles. The Birkbeck Bank in Southampton Buildings, off Holborn, London, is being entirely renewed in polychrome pottery, not only the ornamentation, but the entire architectural construction, so far as it appears externally, of the building being rendered in variously and vividly coloured enamelled terra-cotta. Of course, pottery readily yields itself to excess of elaboration in decorative details, and some will possibly feel that this has happened with the Birkbeck Bank, both in the plastic ornamentation and the colouring of the building; but, none the less, it is a hopeful illustration of what can easily be done to render the streets of London, and other smoky cities of the United Kingdom, as clean, and bright, and cheering in the future, as at present they are dirty, dull, and depressing. The greater part of London, and of Manchester, might rapidly be rebuilt in enamelled terra-cotta, and with the finest effects of both foreground and distance, and with the most charming flamboyance of softened colouring along the skylines. In Lambeth both scenic stoneware and earthenware are now being largely introduced in the internal decoration of public houses. The tap-room of one of them has lately been lined with a polychrome representation of the Lambeth bank of the Thames one hundred years ago, showing the house as it then stood. Nothing could be more attractive. There is, of course, no limit to the potential demand for enamelled tiles and decorative stoneware for these and similar applications. The internal decoration of St. Paul's also at once suggests how profitable it would be for the potters of this country to take up the manufacture of earthenware and stoneware, if not of glass, mosaic cubes or "tesseræ," for the external and internal decoration of public and even private buildings. A great outcry has been raised against the decoration of St. Paul's with mosaic. The practical answer to it is to visit the Cathedral as the work progresses, and I am glad to say that it is progressing without interruption, and to see it in the varying lights and shades of dewy morn and dusky eve and unclouded midday. Words cannot describe the stately splendour of the magnificent and enchanting vision that rises before you in the choir—divine in art of colour and design; and when the whole work is completed, this achievement of the self-denying piety of the Dean and Chapter of the Cathedral, and of the genius of Sir William Richmond, will be regarded in all future time as the crowning architectonic glory of Victorian reign. That the outcry against it should have received any semblance of official support is nothing short of a national scandal.

I have said nothing of the use of unglazed tiles and unglazed terra-cotta mouldings in house building and decoration. There are two highly ornamental chimney-pieces, of dull brick-red terra-cotta, almost as hard, to all appearance, as unpolished jasper, in the Council Reading Room of the India Office, which deserve more attention from architects and decorators than they have received; and the Science Schools, at South Kensington, and the Natural History Gallery (British Museum), opposite to it, are two notable examples of buildings of unglazed terra-cotta. But the objection to its use in both these examples is that it is intentionally made to simulate stone, with the result of painfully disillusioning the admiring student of the noble architectural frontage of the latter building when once the imposition is exposed. The deception in this building is the more difficult of detection owing to the "bonding" of the terra-cotta blocks after the manner of stone masonry.

There is another application of pottery, in the production of bright, showy trinketry. The Egyptians were great adepts in it, enhancing the brilliance of the variegated enamels used in the first firing, by leaving depressed points on the surface of the objects [usually of a prophylactic, phalacterial, or talismanic character], into which fragments of richly-coloured glass were fixed, and fused by a second firing. Gaily painted, and carefully modelled in the minutest details, this dainty trinketry was in design and subtlety of artifice a triumph of the potter's craft and, indeed—to say so without offence—of his craftiness. Stoke might do much in this way to cut out Birmingham, and there would be nothing of the tarnish of "imitation"—of "Brummagem"—about such figular jewelry.

The Artistic Education of the Artisan.

To secure this future, the indispensable requirement was to advance in every way the technical and artistic education of the British potter. That is too large a subject to treat fully in bringing my remarks to a close. I will only say on the point that, it is as true of pottery as of all other artistic industries, it is indeed more true, as clay responds so readily to one's mental suggestions, that the skill of the artisan can be perfected only in the education—the drawing out—of his artistic ideals; and that two things are essential to this. The first is to intimately familiarise the potter with the best examples of his art, and, above all, with the masterpieces of the Greek potters. One has to insist on this in an unhistorical age, in which men are apt, in their degrading ignorance of tradition, to rely too exclusively on their technical proficiency, and overweening conceit of themselves. The second essential, and still greater thing, is

fortunately, innate in all the Aryan races, and deeply implanted in the British races, and that is the simple love and diligent study of nature; the love of our green hills and dales, of the bright flowers of our fields and lanes, the birds that fill our rejoicing skies with song, and the shells and other strange sea things the surging waves wash up on our shores, the colours of sunrise and sunset, and the jewelled constellations of the midnight heavens. The love of these things must be fostered in every way; for, quoting from Longfellow, whose *Keramos* this exhibition and its neighbourhood have vividly recalled to my memory:—

> "Art is the child of Nature; yes
> Her darling child, in whom we trace
> The features of the mother's face,
> Her aspect and her attitude,
> All her majestic loveliness
> Chastened, and softened, and subdued
> With a more attractive grace,
> And with a human sense imbued.
> He is the greatest artist then,
> Whether of pencil or of pen,
> Who follows Nature. Never man
> As artist or as artisan,
> Pursuing his own fantasies,
> Can touch the human heart, or please,
> Or satisfy our nobler deeds,
> As he who sets his willing feet
> In Nature's footprints, light and fleet,
> And follows fearless where She leads."

PATENTS IN 1898.

The report of the Comptroller-General of Patents for the year 1898 has just been issued. For the first time since the Act of 1884 came into force, there has been a distinct falling off in the number of applications for patents, the applications in 1898 numbering 27,659 as against 30,952 in 1897, a decrease of 3,293 or 10·7 per cent. In the year 1895 there was a falling off as compared with the previous year, but the difference at that time was a little more than 300. The Comptroller considers the rapid growth in the number of applications which took place in 1896 and 1897 was to be attributed to the activity of the cycle industry, and that there is little doubt that the decline in that industry has caused the present decline of numbers.

As the 1884 Act has now been in operation for 14 years, the earliest patents granted under it have run out their full time. It appears that 5·5 per cent. of the 1885 patents have been maintained for the full 14-year period; the proportion of the previous year, 1884, was 4·5 per cent. The average percentage of patents granted under the 1852 Act which ran for their full term was 6 per cent., so that the conclusion may fairly be drawn that the reduction of initial fees in 1884 has only slightly diminished the average value of the patents sealed, while it has added considerably to their number.

Of the total number of applications, 17,389 come from England and Wales, 1,395 from Scotland, and 502 from Ireland. There are only three foreign countries from which large numbers of applications come—2,629 from the United States, 2,599 from Germany, and 1,133 from France. There are only eight other countries from which as many as 100 applications come.

An elaborate Table, printed as an appendix to the report, shows the different classes under which inventions may be arranged for the period 1884-97. Later figures cannot be given, on account of the time which may elapse before the acceptance of a complete specification following on an application. There has been a great increase under certain of the chemical classes, attributed to the development of the acetylene industry, which is also responsible for a large increase under lamps. In the following classes the number of patents is said to be practically stationary:—Agriculture, guns and ammunition, sanitation, ships, and textiles. There has been a decrease as regards iron and steel, cutlery, and steam-engines, and a considerable increase in advertising, electric lamps, and photography. Since 1884 the inventions relating to the cycling industry have increased sixfold, but the advance in 1896 was barely maintained in 1897. The numbers for 1898 are not yet fully available, but it is believed that the extraordinary inventive activity in this industry has reached a climax, and now gives signs of abatement. As might be expected, an unusually large number of valueless inventions appear to be included in this increase. Of 6,000 applications made in 1897 in connection with cycles, only 2,300 were completed—much less than the average. An increase in air and gas engines is attributed to the number of inventions for oil engines intended for motor cars. Here, however, there is a decline in 1897, which appears to be continued in 1898. Among minor industries, hat-making and tobacco show substantial increases, and sugar and watch-making substantial decreases. Since the passing of the Workmen's Compensation Act the number of applications relating to guards for preventing accidents with machinery has very largely increased. Immediately after the railway accident at Wellingborough Station, caused by a luggage truck falling on to the line in front of an express train, there was a great increase in inventions for railway platform luggage trucks. As showing the relation between passing events and the course of invention, it is mentioned that the publication in a London morning paper of a letter relating to the waste of horse-feed in London was followed within five weeks by 34 applications for patents for nosebags for horses, the average number per annum being about 12.

THE DIFFRACTION PROCESS OF COLOUR PHOTOGRAPHY.

Nature, for the 29th of June last, contains an excellent article by Professor R. W. Wood, of the

University of Philadelphia, on the ingenious process which he has devised for obtaining the effect of colour in photographs by means of diffraction.

His process is really a modification of the three-colour process of Ives and others, but it has the advantage that only one picture is required, and that copies of the picture can be multiplied. The necessity for coloured screens for viewing the picture is also done away with. If a lamp, a grating, and a lens are arranged in front of a screen, the result will be an image of the lamp on the screen, with spectra on each side. If a small hole is made, say, in the red part of one of the spectra, a person looking through the hole will see the grating illuminated with red light. The position of the spectra depends upon the number of lines to the inch with which the grating is ruled—the finer the ruling, the further removed from the central image are the coloured bands. A finer grating than the one originally employed will, therefore, throw green light upon the hole, instead of red, and a still finer grating will illuminate the hole with blue light. If two overlapping gratings, of which one throws the red light and the other the green on the hole in front of the lens, the spectra will overlap, and the effect to the eye, looking through the hole, will be that the closer-ruled appears green, the coarser-ruled grating appears red, and the overlapping portion yellow—the result of the combination of red and green light. If the third grating is added, the part where all three overlap will be white, produced by the mixture of red, green, and blue light. If a glass plate be ruled with a design, say of a tulip, in which the blossom is ruled with 2,000 lines to the inch, the leaves ruled with 2,400 lines, and the flower-pot 2,750 lines, such a design, when placed in front of the lens, and looked at through the hole, will give the effect of a red tulip, with green leaves, growing in a blue pot.

The principle can be further elaborated and applied to photography. For this purpose three negatives, such as are used to produce a coloured picture in Ives's chromoscope, are required—that is to say, three negatives taken respectively through red, green, and blue coloured filters. Positives are made from these in the usual manner. A plate bearing a film of bichromatised gelatine is placed under a 2,000-line grating, and on the top of the grating the positive, obtained by means of red light. A sufficient exposure is then given. The grating and the red positive are removed, the 2,400 grating and the green positive substituted, and a second exposure made. The same is done for the blue, and the plate then developed. When dried and placed in front of the lens, it appears as a coloured photograph on being viewed through the hole in the screen. In practice, Professor Wood says that he prefers to make two printings on one plate, and the third on another, mounting the two with the films in contact. Once the original picture is made, it can be multiplied indefinitely.

To view the pictures, the only apparatus required is a lens mounted in front of a small screen, perforated with an eye-hole through which the pictures are looked at. Viewed without the lens, the picture is perfectly transparent, and is merely "a diffraction grating on gelatine with variable spacing." The pictures can be projected if a very intense light is used, but great amplification cannot well be obtained.

Theoretically, one of these diffraction pictures can be obtained in the camera on a single plate. This has been done for a single colour, but there are practical difficulties in realising it for all the colours.

Those who are interested in the subject will find fuller details in the *Nature* article, which is illustrated. Without illustrations it is not easy to make the process intelligible.

General Notes.

Central School of Arts and Crafts.—An Exhibition will be opened to the public at the Central School of Arts and Crafts, 316, Regent-street, opposite the Polytechnic, on Monday, July 10th, and remain open throughout the week, from 12 noon to 8.30 p.m. daily. The work done by students includes: — Book-binding, silversmiths', goldsmiths', and jewellers' work, chasing and engraving, enamelling, stained glass, ornamental lead work, stone work (by architects), woodcuts in colour (by a method based on Japanese practice), embroidery, wood-carving aud gilding, &c., also modelling and designs for various processes. Admission will be free. The school was established in November, 1896, by the Technical Education Board of the London County Council, to meet a definite want, viz., to provide for apprentices, journeymen, and others, engaged in the more artistic trades, such training, subsidiary to the workshop, as each student may require in relation to his special craft. Admission to the school is, within certain limits, restricted to those actually engaged in these trades, and no attempt is made to provide for the amateur student of drawing and painting. The school is well equipped with all appliances for carrying on practically the crafts embraced, and with fine examples of old work to serve as a stimulus. The staff is composed of specialists, working under the general direction of Mr. G. Frampton, A.R.A., and Mr. W. R. Lethaby. The third session of the school is just completed, during which nearly 600 students have been in attendance.

Victoria and Albert Museum, South Kensington.—Miss Helen Mary Gulson has recently presented to the Museum a collection of Spode porcelain, comprising vases, cups and saucers, &c., in memory of her uncle, the late Mr. Josiah Spode, of Hawkesyard, Rugeley, Staffordshire.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CHAIRMANSHIP OF COUNCIL.

On Monday, 10th inst., at their first meeting after the annual election, the Council elected Sir John Wolfe Barry, K.C.B., F.R.S., as Chairman for the ensuing year.

The various Committees were also re-appointed.

Proceedings of the Society.

CANTOR LECTURES.

BACTERIAL PURIFICATION OF SEWAGE.

By Dr. Samuel Rideal, F.I.C.

Lecture II.—Delivered January 23, 1899.

A partial recognition that natural purification of organic matter was due to living organisms was arrived at early in the present century, when Cagniard de la Tour discovered that yeast was a living plant, and Schwamm demonstrated that putrefaction was due to something in the air which heat could destroy, and that meat would not putrefy in calcined air. It was suspected therefore that organisms were the actual cause of decay and putrefactive change, but the powerful advocacy of Liebig and his school of the so-called "Catalytic" theory delayed the general acceptance of the "germ theory" for more than thirty years. It will be recollected that in the catalytic theory it was believed that some organic substances, in the act of undergoing decomposition, possessed the power of causing the alteration and decay of other organic substances in contact with them, and this mechanical, as distinct from a biological, explanation, held its own until Pasteur proved that fermentation and putrefaction did not take place in the absence of living organisms, which he divided into aerobic, or thriving in presence of oxygen, and anaerobic, or growing without it. Their life history and characters have since been elaborated by Koch and a number of other observers. On the other hand, the well-known purifying action of soil, beyond the mere mechanical straining, was, up to a late date, considered to be purely chemical, and due to oxidation. E. Frankland, in 1872, had pointed out that "a filter must not be considered as merely a mechanical contrivance, the process carried on being also chemical." This was true, but the necessity of the co-operation of life in the processes was at first almost ignored, more especially as in nitrification, one of the most important of the actions, no accompanying special organism had been discovered. We now know that this was due to the fact that the microbic group responsible for nitrous and nitric changes would not grow in the gelatine or other media ordinarily used for cultivations. The researches of Warington, P. Frankland, Schloesing, Winogradsky, and others, resulting in the isolation of nitrifying and denitrifying organisms, removed the difficulty, and, in 1872, the Berlin Sewerage Commission reported that sewage matter was converted into nitrates, not by a simply molecular process, but by organisms present in natural sewage and soil. Muntz, Müller, Marie Davy, and others also demonstrated in various ways how the purification of sewage was accomplished by bacterial action.

Sorby, in 1883, remarked on the very large proportion of the detritus of fæces which was lost in the river, owing to the action of "countless thousands of living creatures," and Dupré, in a report to the Local Government Board in 1884 on the results of his experiments on aeration, stated that "the consumption of oxygen from the dissolved air of a natural water is due to the presence of growing organisms, and that in the complete absence of such organisms little or no oxygen would be thus consumed." In May, 1886, Dupré proposed "to cultivate the low organisms on a larger scale, and to discharge them with the effluent into the river, as the power these lower organisms had was remarkable."

In the following January, Dibdin, speaking at the Institute of Civil Engineers, on the precipitation of sewage, observed that "One object claimed for the use of an excessive quantity of lime, and also for some other substances, is that they destroy the living organized bodies, such as bacteria, &c., which

gave rise to the phenomena known as putrefaction. . . . As the very essence of sewage purification is the ultimate destruction, or resolution into other combinations, of the undesirable matters, it is evident that an antiseptic process is the very reverse of the object to be aimed at."

In this connection the same authority has remarked that "very alkaline effluents, such as those produced by the use of lime in excessive quantities, are very liable to putrefy instead of becoming purified by oxidising organisms."

In 1887, the Massachusetts State Board commenced their well-known series of experiments on the purification of sewage by filter beds, showing the effects of intermittent filtration with the aid of aerobic bacteria, and working out details of various porous materials, size of grains, thickness of strata, influence of time, temperature, and different methods of procedure. The results were on rather too limited a scale to be exactly comparable with practice, but the general deductions have been amply confirmed by the success of larger sewage works on biological principles both in Europe and America.

It soon became evident that if a filter bed were worked continuously, it rapidly choked, and putrefaction occurred in the interior owing to a deficiency of aeration, so that on the aerobic plan it was necessary to work intermittently, draining out the liquid, and allowing the entrance of air during regular intervals of rest.

Otherwise it was necessary to have "very slow motion of very thin films of liquid over the surface of particles having spaces between them sufficient to allow air to be continually in contact," a condition, however, which did not prevent the sand filters from becoming overburdened and also greatly limited the amount of sewage treated. In the Massachusetts Report of 1890, the process is compared to a combustion, and was found to be most rapid in the summer months. The same Report gives useful information on the methods of analysis, besides observations of the number of bacteria and algæ, and valuable descriptions of the species found in the effluents. It must be remembered that sewage in America is usually weaker and of greater volume than it is in Europe, on account of the more abundant supply of water.*

The sewage of Lawrence City, in the Massachusetts investigation, had been run on the filters without any previous purification, or even settlement. On the other hand, our sewage of London had undergone a previous preparation, by being treated with 1 grain per gallon of ferrous sulphate and 4 grains of lime, the precipitate of sludge being then conveyed in boats to be discharged at the mouth of the Thames. It was hoped that the clarified liquid, after the precipitation, could be discharged into the river direct without creating nuisance. But it still contained about 10 parts per 1,000, or 7 grains per gallon of suspended solids, and was by no means free from odour. The Royal Commissioners of 1884 had decided that the liquid could not be discharged at the outfalls as a *permanent* measure, and required further purification by application to land.

In 1866 an experiment with London sewage as applied to land had already been made at Barking. The Metropolis Sewage Company obtained a concession to treat the sewage of North London, amounting to about 2,000 tons in 9 or 10 hours, on five or six acres of grass land on a light gravelly soil. The experiment was not a success, either culturally or with regard to the cleansing of the effluent. But when we come to the 200,000,000 gallons daily of London sewage, it will be obvious that the requisite area of suitable land is entirely unattainable. This being recognised, and an extension of chemical treatment and precipitation having proved to be inadequate as well as costly, the Main Drainage Committee of the County Council in 1891 determined on a series of experiments at Barking outfall, on the lines of the Massachusetts researches. From the preliminary investigations with small filters, it was considered that coke-breeze was the most suitable material, although burnt ballast was found to nearly equal it in purifying efficiency. Sand and gravel effected a greater clarification, but the removal of dissolved organic matter, as measured by the reduction in the oxygen consumed, given in Mr. Dibdin's Report, was considerably less than with the coarser materials. Moreover, there seemed a tendency for the effluent to become putrid, owing to deficient aeration from the closeness of texture, while the filter required frequent scraping and renewals. The average rate of working, including periods of rest, was 411,000 gallons per acre, or 250 gallons per square yard, in 24 hours. For eight hours a day the effluent ran continuously, the filters being kept

* The daily consumption of water per head in New York is 92 U.S. gallons; in New Jersey town and cities, 92 gallons; in Philadelphia, 143; in Los Angeles, California, 200; in Alleghany, Pennsylvania, as much as 247 gallons. (10 U.S. gallons = 7 imperial.) (Mason.)

full; the filter was then emptied, and allowed to rest for 16 hours.

The figures given by Messrs. Dibdin and Thudichum, who conducted the experiments, are as follows:—

Clarification, as measured by the units of depth required to obscure standard mark:—Burnt ballast, 1; coke breeze, 1; pea ballast, $1\frac{3}{4}$; sand, $2\frac{1}{4}$.

Reduction of Organic Matter (oxygen consumed):—Burnt ballast, 43·3 per cent.; sand, 46·6; pea ballast, 52·3; coke breeze, 62·2.

The report adds significantly "the number of organisms in the tank effluent before filtration, and in the filtrates, was found to vary very considerably, *those in the filtrate being generally present in larger numbers;* but it soon became apparent . . . . . . that the presence of a large number of organisms was evidence of the activity of the process of splitting up the organic compounds in the sewage matters passing through the filters. Here it is clear that the main purification was bacterial, and only the beginning of a further resolving change to be carried on in the river. It would undoubtedly have been an advantage if the biological process so initiated could have been allowed to develop a further stage in the filter, but the prescribed object of the experiments was the attainment of the highest rate of speed consistent with such purification as would remove the obvious objectionable characters such as odour, colour, and liability to putrefaction."

The further experiments with a one-acre coke breeze filter at Barking are well-known. As at Massachusetts, it was found that continuous running resulted in clogging and a foul effluent, and that to obtain the best results the commencement must be made with small quantities of liquid, the filter, which was composed of 3 feet of coke breeze and 3 inches of gravel, being at first merely filled and emptied twice daily, with a view to obtaining an active bacterial bed. Daily determinations were made of the oxygen absorbed, albuminoid ammonia, and nitrates. At the end of a month, when the highest efficiency was reached, amounting to 83 per cent. purification, the quantity of effluent was increased by stages to one million gallons daily, while the time of rest was shortened. The filter was finally worked on the system which has been found the best at Barking, Exeter, and Sutton, namely, alternate filling, resting full, and emptying, with a periodical entire rest empty for complete aeration. At Barking, the filling occupied two hours, the standing full one hour, the emptying five hours, so that three cycles of eight hours were completed each day. From 10 p.m. on Saturday till 6 a.m. on Monday the filter rested empty, making a period of 32 hours each week. This weekly rest involves the storage of the crude effluent in reservoirs for the corresponding period—a practice which has many objections. At Exeter, where the flow through the septic tank is continuous, and no reservoirs are employed, the cycles are continued, by means of the automatic gear, throughout the entire week. Should a filter show signs of exhaustion, which occurs at long intervals, or rarely through accident, it is thrown out of use for one or two weeks till recuperated.

The one-acre filter is still in use. It is reported that after five years' working it is free from clogging, and its working capacity is not impaired. Its depth is now being doubled, to see whether any increase of efficiency will ensue from a deeper layer.

TABLE I.—AVERAGE ANALYSES FROM ONE-ACRE FILTER (DIBDIN).

Parts per 100,000.

Date.	Average per acre per day.	Oxygen absorbed in 4 hours.		Albuminoid ammonia.		Nitrogen as nitrates.		Per cent. purification by oxygen absorbed.
	Gallons.	Effluent.	Filtrate.	Effluent.	Filtrate.	Effluent.	Filtrate.	
April 7th to June 9th, 1894 ..	500,000	5·85	1·23	·593	·138	·182	·340	79·3
Aug. 3rd to Nov. 9th, 1894 ..	600,000	5·18	1·42	·565	·158	·032	·200	79·6
Nov. 1894 to March, 1895....	1,000,000	5·87	1·33	·545	·160	·565	1·00	77·5
April 8th to April 20th, 1895..	1,000,000	5·00	1·26	·514	·146	·204	1·10	75·4
May to Sept., 1895..........	1,000,000	6·62	0·91	—	—	—	—	80·7

At the period when it was believed that the purification of sewage was almost entirely effected by chemical processes of oxidation, attention was divided between chemical methods of oxidation by materials like the manganates, permanganates, chlorine, and others, which proved in practice to be expensive and not final, and mechanical devices for freely exposing to air, or even forcing it continuously or intermittently into the liquid. The patents are very numerous, and include the use of perforated screens, weirs, cascades, and the use of air heated, charged with vapour, or under pressure. Electrolysed sea water, and other electrical processes have also been tried without much success. Many of these have been started with an idea that the final products might have a sale which would help to balance the cost of the process. But since this hope has not been realised, chiefly on account of the great dilution, even a strong sewage only containing about 100 parts of total solids in 100,000, or 0·1 per cent., a great part of which is worthless inorganic matter, and only about 20 to 30 parts per 100,000 of nitrogen in all forms, with an even less proportion of other substances of value, it soon became evident that the only expenditure which could be incurred was that which was rendered absolutely necessary for sanitary reasons. Therefore the introduction of the natural, and to a great extent, automatic process, was an immense advance. Yet while exclusive attention was given to the aerobic organisms, various schemes were proposed for the artificial aeration of the filters.

Under Lowcock's system, as described in a paper read before the Institute of Civil Engineers in 1893, air was forced under an average pressure of $4\frac{1}{2}$ inches of water, either continuously or at intervals into the body of the filter, which was constructed at first of gravel, and afterwards, at Wolverhampton, of coke breeze. It is claimed that the filtering area required is thus reduced to 3·8 acres per million gallons, and that the percentage purification of the sewage is "considerably over 90 per cent." At the same time, the expense of pumping air must needs be very great.

About the same time Waring, in America, proposed a method of forced aeration which differs from Lowcock's mainly in the separate treatment of the sludge by means of "aerators." The system, which is somewhat complex, was first installed at Newport, N.Y., in 1894.

This city was sewered under the combined system, and the liquid became frequently admixed with sea water entering the sewers, the effect being an increase of the suspended solids by precipitation of soap and other matters. This precipitation has been often noticed in tidal reaches, and has resulted in the formation of banks and deposits on the bed. It would seem that the lime and magnesia present in ordinary waters do not secure the removal of all the higher fatty acids as the greasy scum seen frequently in sewers. From examination of the soluble part of sewage I have found that soda salts of oleic and other fatty acids are still present, especially in towns with a soft-water supply, owing probably to the influence of the ammonia formed. These soluble soaps are decomposed and precipitated by the high amounts of calcium and magnesium salts existing in sea-water, so that the sewage of Newport contained unusual amounts of soap curds.

The sewage first passed through a settling chamber for road detritus, and was thence pumped alternately through either side of a divided tank containing a shallow bed of coarse broken stone to arrest the coarser solids. "The impurities in the section thrown out of use disappeared rapidly in its interval of rest."

The liquid next passed slowly through four straining tanks filled with stones and gravel, whose function was said to be "mere mechanical sedimentation." As soon as these became clogged a plug was drawn, and the sludge emptied into a separate "aerating tank," filled with stones and gravel, where air was driven constantly through the mass, and as soon as active bacterial action had set in the sludge was rapidly dissolved.

Air was also forced through the straining tank till it was again in condition for use. Apart from the complexity of the system, we have here, in place of the regular intermissions for rest and aeration as used in England, a continuous working, assisted by forced aeration, with its accompanying expense, at longer intervals, the compensating point being claimed that a larger volume of sewage can be treated. The action here is obviously entirely aerobic, but as we shall see later, can be obtained better by a preliminary anaerobic treatment.

Following the success of the Barking experiments, an installation on the same principle was started at Sutton, Surrey, at the beginning of 1894. The filters were of different materials, but again showed coke breeze to be the best, with burnt ballast as a good second, the latter being very simply constructed by digging out

the clay to form a pit about 3 feet deep, and filling it up with the same clay after burning, the cost of a filter of this kind, having an area of rather more than one-tenth of an acre, being given as less than £100, including all charges. It will be remembered that the cost of the Barking one-acre coke filter was stated as £2,000.

Up to this time the filters had been fed with an "effluent;" that is, a sewage prepared by straining, partial chemical precipitation with lime and ferrous sulphate, and sedimentation. In November, 1896, it was determined to abandon precipitation and to prepare the crude sewage, after the removal of the grosser particles by screens, by running it into a "bacteria tank" containing coarse burnt ballast, previously inoculated with a liquid containing the bacteria which had been found effectual. The fluid from the tank was further purified, as formerly, by coke breeze filters.

After three months' working Mr. Dibdin was able to give a satisfactory report. The oxygen consumed by the organic matter was reduced by the tank 66 per cent., and by the filter beds to 86·5 per cent. The solids in suspension were reduced by the tank 95 per cent., and by this and the filter 99·6 per cent., while the filtrate was practically clear, had no objectionable odour, and did not putrefy on keeping. The process has continued to the present time with satisfactory results, except when the filters were overtaxed, "some of them," as Mr. Dibdin reports, "having been purposely worked up to a rate of nearly three million gallons per acre per day, with the result that the bacterial action was evidently checked, as shown by a decrease in the production of nitrates and an increase in the quantity of organic constituents in the effluent. As the result of careful watching, however, no permanent harm was done, as the filters were immediately restored to their usual condition, when they proceeded to give good results."

This remark points to the conclusion that when there is reliance on presumably aerobic filters and organisms for combined liquefaction and nitration, indiscriminately, in the same receptacles, the result is apt to be variable, and to depend on "careful watching," an inference that is borne out by Mr. Dibdin's figures as given in his later report of analyses during 1896 and 1897.

The average results in his Table I have calculated, for the purpose of comparison, to a uniform chlorine content of 12·84 parts, which is the average given for the Sutton crude sewage.

TABLE II.—SUTTON SYSTEM (parts per 100,000).

	Cl.	Oxygen absorbed in 4 hours.	N as nitrites.	N as nitrates.	Free NH_3.	Albuminoid NH_3.	Suspended matter.	Residue on micro-filter millimetres per litre.
Crude sewage ...	12·8	6·49	·021	None	12·53	1·13	85·76	3000
Tank effluent......	12·8	3·06	·301	·751	3·85	0·60	5·1	213
Filtrate from coke breeze	12·8	1·19	·087	1·99	1·25	0·316	1·35	23

These figures show the following percentages of purification :—

	Oxygen absorbed.	Free NH_3.	Albuminoid NH_3.	Suspended matter.
By the "bacterial tank"........	53	69	47	94
By the coke filter	29	21	25	4·4
Total purification	82	90	72	98·4

It will be observed that the chief purification occurs in the bacterial tank, and that a large proportion of it consists in the removal of the suspended solids. The following are further particulars of the Sutton Works :—

The bacteria tanks are three in number, con-

tain 3½ ft. of burnt clay ballast, and are 183 square yards in area. The times required are :— Filling ¾ hour, resting full 2 hours, emptying 1½ hour, resting empty 2 hours. Two or sometimes three cycles are completed per day, according to the flow.

The population of Sutton is 13,000, and the daily dry weather flow of sewage, on the separate system, is 350,000 gallons. At present only part of the sewage is treated bacterially. The beds have been working for the last three years, the coarse bed dealing with the screened sewage at a rate of about 100 gallons per square yard per day, and the fine bed at a rate of about 150 gallons per square yard per day; 10 acres of beds are therefore required to treat 3,000,000 gallons of sewage per day after it has been properly screened.

During the two hours of resting full, a mixture of organisms, of which I believe a great proportion are anaerobic, as indicated by the large production of nitrites, are liquefying the sludge. It was estimated that in the three tanks 80 tons of dry matter had been thus reduced from November, 1896, to December, 1897. During the period of resting empty, the aerobic bacteria are supposed to be at work, although, according to Mr. Dibdin, no air enters except that drawn in while emptying out the liquid. The subsequent coke breeze filter is intended, under the same conditions, to be entirely aerobic and nitrifying. Here also the presence of nitrites may be remarked.

It will be noticed, further, that the Sutton sewage has already been broken down to a very considerable extent, as shown by the 12·53 parts of free ammonia, and only 1·13 parts of albuminoid.

An automatic rotary screen is used to intercept the coarser matter before the sewage is applied to the tanks. The amount of this intercepted material is stated in Mr. Thudichum's recent paper (Soc. of Engineers, Dec. 5th, 1898) to be about 30 barrow loads per day per 1,000,000 gallons. Mr. Thudichum also remarks that "practical points requiring further investigation are the trapping of sand, the duration of life of the coarse beds, and the degree of fineness for the screens. In the septic (Cameron) tank everything organic may be permitted to enter."

At Oswestry the Sutton system was adopted in the beginning of 1898. The material for the beds was obtained by screening from an old refuse tip, from which, according to the engineer, everything excepting hard carbonaceous matter had disappeared. The coarser portions are used for the "primary" filters, 4½ feet deep, corresponding to the Sutton "bacteria beds," and the intermediate portions for the "secondary" filters, 4 feet deep, intended to be equivalent to the Sutton coke breeze. This screened refuse costs about 1s. 3d. per cubic yard in the filter beds, and is believed to be already charged with organisms. The crude sewage is not passed at once on to the beds, but is previously clarified by subsidence in settling tanks. The report states that about half the sludge settles in these tanks, and is removed weekly, mixed with the dust screened out of the town refuse and sold as manure. The population of Oswestry is 10,000, the dry weather sewage 300,000 gallons per day, and the water supply 20 gallons per head. Total costs of works (when completed) £1,800, annual working expenses about £80.

Other experiments carried on during the past twelve months with the Sutton method on the sewage of Leeds at first showed considerable difficulties owing to "sludging-up" of the beds, but by increasing the periods of rest so as to allow the retained organic matter to be dissolved, and by the introduction of finer screens which remove a greater portion of the suspended solids (sludge) to be otherwise dealt with, more satisfactory results are being obtained.

It is remarked, however, in the Leeds report, that if the resting period were too prolonged, "the large increase of capacity gained by rest was, to a great extent, lost within a short time" (p. 33). Thus, after a suspension of 38 days, the capacity was reduced in a fortnight from 56,500 to 45,800, or 10,700 gallons. I would venture to suggest as a reason that the long aeration had destroyed or enfeebled the anaerobes, and that the liquefaction was therefore suspended until an anaerobic state was restored.

Colonel Harding (the Lord Mayor) and Mr. Hewson, the City Engineer, who together drew up the report, conclude as follows :—

"The question is raised as to whether an experiment should not be made without delay to ascertain the effect of the septic tank treatment for the destruction of the solids in suspension ; also to see how far an open (?) septic tank, or upward septic filtration through coarse material, covered with a layer of sand, would be effective in destroying the sludge, and so far relieving the filter beds."

With Leeds sewage, the experience gained shows that 400,000 gallons per day can be dealt with on ½ acre of coarse bed and ½ acre of fine

bed, or 1 acre per day in all, after the grit has been removed in a settling tank, and the grosser solids (paper, fibre, &c.) screened off. This gives a minimum of 50 acres of beds for 20,000,000 gallons; but in order to have spare beds, it is recommended to have 70 or 80 acres, or say 4 acres per 1,000,000 gallons.

Leeds, under the old system, would have to deal with 300 tons of sludge per day, or say 100,000 tons per annum. By settling the grosser solids, the suspended matter could be reduced, according to the same report, from 37·2 grains per gallon to 25 grains per gallon, and the filter beds would not then sludge up. This leaves, however, about one-third of the total quantity, corresponding to the 100 tons of sludge per day of the present precipitation process still to be disposed of.

Ducat Filter.

Colonel Ducat, with a view of introducing automatically a larger supply of oxygen, has devised a filter with walls composed of perforated tiles, or of drain-pipes laid horizontally, so that air can have free access to the body of the material without pumping. The bed is coarse-grained above and fine below, and the action is intended to be exclusively aerobic, as atmospheric oxygen in excess is brought in contact with the contents at once without giving any period of anaerobic incubation, and therefore presents some points of resemblance to the Waring process already mentioned. I have pointed out elsewhere that in towns with old and long sewers, or where storage is practised, the liquids may have already received sufficient hydrolytic resolution to be quite prepared for a strong aeration such as this filter supplies. The system is under trial at Hendon, and also experimentally at Sutton.

This is illustrated by an analysis furnished by Dr. Houston:—

	Oxygen absorbed.	Free ammonia.	Albuminoid ammonia.	Oxidised nitrogen.
Sewage, Oct. 14th, 1898	14·72	8·7	1·6	—
Filter effluent, ditto....	0·78	0·3	0·094	·477

The high free ammonia and the low albuminoid shows that the sewage has already undergone the preparation I have mentioned. The nitrification of the effluent, indicated by the "oxidised nitrogen," has not proceeded as far as might have been expected, notwithstanding the very large loss of ammonia. The oxidation of the carbonaceous matter to carbonic acid is also most marked.

Garfield Coal Filter.

Dr. Bostock Hill, in a paper at the Leeds Sanitary Congress in 1897, gave a very favourable account of the use of fine coal for the filtration of effluents which had been previously chemically precipitated, at Wolverhampton, Lichfield, and other places. The sewage of Wolverhampton is heavily polluted with chemicals, that of Lichfield contains a large amount of brewery refuse. Dr. Hill observes that "the action of coal is different from that of other media in that analysis shows a far greater difference in the oxygen absorbed before and after filtration than in the organic matter as measured by albuminoid ammonia."

"As far as is known any kind of coal will do, but it should be as clean as possible, and the depth should not be less than 5 feet." At Lichfield the first layer, over the drain pipes, is ½-in. cube coal, then a little ¼-in., afterwards 2½ feet of 1-8th inch cube, and 2½ feet of 1-16th inch, ending with 6 inches of 3-16th coal dust. The liquid is supplied continuously for 12 hours, with 12 hours rest, and the rate is a 1,000,000 gallons per acre per day. The effluent is said to be bright and clear. He adds that "as a result of 12 months working the efficacy of the coal has increased. At first it would appear that the action is a chemical one, because the oxygen absorbed is at once directly affected; afterwards, however, nitrates are produced in considerable quantities, so that probably there is then a double action, chemical and bacteriological. The interior of the filter, after many months, has nothing but a slight earthy smell." This filter was introduced by Mr. Garfield in the summer of 1896.

Mr. Fowler, in his report of the Davyhulme experiments, in 1897, confirms the results of previous observers that coal and burnt clay filters, when worked continuously, rapidly become clogged, and that improved results are obtained with intervals for rest and aeration. He considers coal to be superior to burnt clay.

In the experiments with Manchester sewage the liquid dealt with was usually an effluent which had been treated with chemicals, such as lime and sulphate of iron or alumina, a procedure which robs the liquid of its natural bacteria, or inhibits their action. The work of bacteria is repeatedly recognised, and yet,

even where, as at Accrington, Oldham, and other places, a treatment is adopted which is called biological, merely as a supplement to chemical and mechanical processes, we meet with such phrases as "Both the tank effluent and the cinder filtrate were tested for nitrites and nitrates practically without result" (Oldham); "There is practically no formation of nitrates in the filters at Swinton;" at Accrington, "nitrification in final filter *none*;" at Salford, "the large excess of lime present acts as a *temporary sterilising agent*." We cannot be surprised, therefore, that nearly all the effluents were found liable to subsequent putrefaction, or at the result that the anaerobic changes which had been suspended by the treatment, are resumed imperfectly and irregularly in the Ship Canal or the rivers.

In December, 1897, a Rivers Sub-Committee of the Manchester City Council visited representative sewage works at Barking, Friern Barnet, Sutton, Oldham, Swinton, Chorley, Glasgow, Salford, Hendon, and Accrington. In March, 1898, their report was approved and a deputation was appointed to wait on the Local Government Board. The conclusions of the Committee are shortly:—

1. That filtration by land is altogether impracticable.

2. That no practicable system of precipitation by chemicals alone has been laid before them which will meet the requirements of the Mersey and Irwell Joint Committee.

3. That the method most reasonably practicable and available is the biological filter or bacteria bed, such as may be seen in operation at many of the places visited.

After some delay and correspondence, two bacteria beds of coke breeze were completed at Davyhulme on September 14, 1898, under the superintendence of the three experts appointed—namely, Baldwin Latham, Percy F. Frankland, and W. H. Perkin, junr. The working capacity of each filter is 5,000 gallons, and the liquid to be purified is taken direct from the sewer and passed into a settling tank for an hour before proceeding to the first or coarse filter. After remaining in the latter for one or two hours, "according to circumstances," the partially purified sewage is transferred to the fine filter, where it again rests for a period of one or two hours. Each filter requires three-quarters of an hour for filling, and the same time for emptying. Samples are taken every five minutes during emptying, and mixed for analysis. The figures show, as in other cases, that an improvement occurs as the filters mature. At first, the beds were filled once a day with settled sewage and twice with crude, and under these conditions the capacity of the coke filter remained constant. With regard to trade refuse, Mr. Fowler reports that iron pickle (ferrous chloride), dye refuse, carbolic acid, and sulphocyanides from gas liquor, are all removed or oxidized, that "in no case has the presence of manufacturing refuse showed a marked tendency to make the purification less effective" (an opinion also shared by Dr. Perkin), though "it is probable that with purely domestic sewage the yield of nitrate would be larger."

The three experts also state in their report that "the bacteriological system, without the use of any chemicals, notwithstanding the peculiar nature of the Manchester sewage, will purify that sewage, and yield an effluent which will comply with all the requirements of the Mersey and Irwell Joint Committee, and will, in our judgment, be the means of greatly improving the waters of the Ship Canal."

The Local Government Board held an inquiry at Manchester, on January 12th and 13th, 1899, with reference to the application of the City Corporation to borrow £160,000 "for purposes of sewerage and sewage disposal." It was explained that Manchester had tried filtration by land and chemical treatment, but neither of these had been satisfactory. Eleven tanks had now been constructed at Davyhulme, each 300 ft. long by 100 ft. wide, and 6 ft. deep, with a united capacity of 12 to 15 million gallons, equal to half a day's dry weather flow. The population of Manchester was 520,000, and was increasing at the rate of 4,700 per annum. The tanks were originally used as chemical filters, the treatment and removal of sludge costing about £17,000 a year, the chemicals alone reaching £90 per week. It was then proposed to utilise these tanks for settling the raw sewage, which would subsequently pass through sixty acres of double contact beds filled with coke breeze. An effluent would then be introduced without the use of land, which would practically conform to the present requirements of the Mersey and Irwell Joint Committee. It is also stated that if the "double contact" did not suffice, they would employ a "third contact." The inquiry was adjourned for further details. The first contact beds of 30 acres were to be constructed of coarser material than the second 30 acres of second contact beds.

From a later report it appears that nitrifi-

cation has at length been attained, the highest result being 0·68 of nitric nitrogen, but the average only reaching 0·27. In the Tables given they are called "double filtration" experiments, and as a fact they are neither anaerobic nor properly aerobic as the poor result in nitrification shows. Better results, as we shall see later, could probably be obtained by making the first filtration more anaerobic and by ensuring better aeration in the second filters. It will also be noticed that sedimentation in tanks is required by Manchester as essential for the proper working of the contact beds. This sedimentation, therefore, is the equivalent of the screening adopted by Mr. Dibdin, at Sutton, and the chemical precipitation of the earlier experiments before passing on to the one acre filter bed in the London County Council experiments.

[NOTE.—The adjourned inquiry was concluded on May 1st, 1899, when the experts gave satisfactory reports of the working of the experimental beds since January. On learning that the effluent was passed into the Ship Canal, the Local Government Board inspectors observed that "pending the report of the Royal Commission, the Board was not prepared to depart from what it has laid down as to the provision of land for the treatment of effluent." The Corporation have shown that 300 acres of land could be made available below the filter beds, if necessary.]

Miscellaneous.

AGRICULTURAL EDUCATION IN FRANCE.

A considerable amount of attention has been given in France to what may be termed general agricultural education. Agricultural teaching, of a more or less rudimentary order, has been made obligatory at elementary schools, and a small garden for practical illustration has been attached to many of these institutions in rural districts. The Commercial Attaché to H.M. Embassy at Paris says that the instruction given at elementary schools has produced most beneficial results. In one particular case the teacher, by the introduction of new methods, has about doubled the average production of wheat. Special professors also form part of the staff at 76 of the boys' superior primary schools, at 2 similar schools for girls, at 72 colleges, and at 12 lycées. These figures relate to the year 1898. This general instruction may be divided into distinct sections; firstly, that given by the departmental professors; and, secondly, that given by the special professors. In accordance with the provisions of the law of June 16, 1879, a travelling professor of agriculture has been appointed to each department. These professors are selected by open competition, each post being made the subject of a separate and special examination bearing upon general agriculture, viticulture, arboriculture, horticulture, and the sciences connected with those subjects, in their application to the conditions obtaining in the particular department in question. The examiners are nominated by the Minister of Agriculture, and include—the Inspector-General of Agriculture, the Inspecteur d'Académie, a professor of chemistry or of physics, and a professor of natural sciences. The two latter must be chosen from amongst the staff of either the Institut Agronomique, or of one of the national agricultural schools, a professor from the nearest veterinary or medical school, three agriculturists chosen from amongst the members of the departmental agricultural association, and a member of the general council. The candidates must be at least 25 years of age. These professors are, owing to the two-fold nature of their duties, partly under the Ministry of Agriculture, and partly under the Ministry of Public Instruction. The expenditure for their salaries is therefore shared equally between the two Ministries. They are divided into four classes, with salaries as follows:—First-class, £180; second-class, £160; third-class, £140; and fourth-class, £120. The duties attached to these positions may be divided into two distinct sections—(1) general instruction of adults—in the service of the Ministry of Agriculture; (2) teaching in the normal schools—in the service of the Ministry of Public Instruction. The tuition for adults takes the form of lectures, delivered in different parts of the department. The number of lectures given by each professor during the year must not be less than 26, but it would appear that the minimum is generally exceeded. The lectures are intended to enlighten landed proprietors, farmers, and others, as to the best agricultural methods, the applications which can be made of scientific discoveries, &c., in a word, to assist them in reaping the greatest possible profit from their land. The subjects treated naturally vary greatly according to the needs of the population of each department; the lectures, however, possess one characteristic in common, they are of an essentially "popular" type. The lecturer also, at the close of each lecture, places himself at the disposal of his audience, with the object of advising them individually regarding special questions, and of elucidating any points touched upon in his discourse which they may have failed to grasp. The most powerful aids to this class of teaching are found in the "experimental" and "demonstration" fields. The first serve for experiments respecting the adaptability of different kinds of plants and crops to various soils, for the testing of chemical and other manures, &c. The second, though the most important, are in a measure subsidiary to the first. Here the professors making use of their knowledge of the general conditions obtaining in the department,

and of the results of their personal experience, aim at producing the best possible crops, in order to convince the sceptical of the success of their methods by ocular demonstration. This form of teaching is highly thought of by competent authorities. M. Tisserand, who was Minister of Agriculture, remarks :—" The results are certain ; one may without fear say that the demonstration fields have been amongst the powerful factors in increasing our agricultural production." In the departments where this system has been inaugurated the average number of experimental fields is said to be between eight and nine, and of demonstration fields between 35 and 40. In both cases the fields are usually a little over an acre in extent. The cost of organising the system and of maintaining it is provided for partly by Government subsidies, partly by departmental grants, and partly by the subscriptions of agricultural associations. In his capaeity of teacher at the normal schools, the professor gives two lessons a week during the winter terms to the combined second and third year pupils. These lessons treat of agriculture, zootechnics, and horticulture. The theoretical teaching is supplemented by practical work in the gardens, the experimental fields, &c., and by various excursions. These classes were instituted in order to enable teachers at primary schools to give elementary instruction in agriculture, and the law concerning departmental professors contained a provision that such courses of tuition should begin within three years of the nomination of the professors. The special professors already mentioned have much the same duties as the departmental professors, so far at least as the instruction of adults is concerned, and are in this respect subordinate to them. The difference in their functions has been thus defined by M. Tisserand: "The task of the first (departmental professor) is to teach the agricultural classes, that of the second (special professors) to inform them." The special professors are attached to superior primary schools, to colleges, and to lycées. They hold agricultural classes in these establishments, and deliver two lectures a week in winter, and one in summer for adults. Their teaching is confined to the "arrondissement" in which the institution to which they are attached is situated. Candidates for these professorships must be twenty-five years of age, and possess either the diploma of agricultural engineer, or that of a national agricultural or veterinary school. The posts are, according to a new regulation, to be awarded by an examination having retrospective effect in the case of those nominated merely on the strength of their diplomas. The examination would appear to be very complete. It includes the theory of agriculture and kindred subjects, the application of various sciences thereto, several practical tests, the writing of a report, and the delivery of a lecture. The instruction given in the schools is spread over two years, and consists of two lessons per week. During the first year the pupils are taught agriculture and horticulture; during the second, zootechnics, rural economy, and book-keeping. The special professors are divided into four grades. Promotion from one grade to another can only take place after three full years' service. The exceptional grade is exclusively composed of men of at least 15 years standing, of which five have been passed in the first-class. The salaries are as follows :—Exceptional class, £136 ; first-class, £120 ; second-class, £108 ; third-class, £96. The results attained by these two classes of professors, particularly the departmental professors, would seem to have been such as amply to justify their cost to the State. In conclusion, attention should be called to the agricultural stations and laboratories which, though not properly coming within the sphere of educational establishments, render considerable service to the agricultural population. They are, for the most part, departmental institutions subsidised, to a varying extent, by the State. They numbered 59 in 1898, in addition to 6 of special type attached to the Institut Agronomique in Paris. The laboratories make analyses of manures, soils, products, &c., upon demand, and against a fixed rate of payment. The agricultural stations, on the other hand, have been instituted more with a view to the carrying out of scientific and practical experiments of general utility to the inhabitants of the districts in which they are situated, such as the detection of fraudulent practices in connection with manures, seeds, &c. ; they are intended, moreover, to be centres of information, both for the professors and for the public, in regard to all the latest scientific and practical improvements connected with agriculture in its widest sense.

OYSTER CULTURE AT SPEZIA.

The first attempts to cultivate oysters at Spezia were made in 1887, and after a few years the industry developed so rapidly that the production rose from about 150,000 oysters in 1891 to more than 6,000,000 oysters in 1898. The method practised is the same as at Taranto, with several modifications rendered necessary by the difference of situation, temperature, &c. According to the British Vice-Consul at Spezia, the method consists of suspending twigs of lentiscus in the months of May, June, and July, in about 40 feet of water, on the inner side of the "diga" or breakwater, across the gulf, which is about nine miles from the town. These twigs serve as "collectors" for the embryos and are kept suspended there for one or two months. When the twigs are sufficiently laden with young oysters they are removed to the "sciaja" or enclosures, where the twigs are cut into short pieces, inserted crosswise into the strands of ropes of esparto grass, and again suspended in water varying from nine to twenty-one feet deep. The oysters are kept there for twelve or fifteen months, and when they are developed and fattened enough they are taken to the depôts closer inshore. Here they are separated from the mussels clinging to them,

and the twigs, scraped, sorted, and packed in baskets (with their mouths upwards to retain water), and despatched by rail to Genoa, Turin, Milan, and other Italian markets. Those kept for local consumption and for re-sorting are placed in baskets of iron wire and kept hanging in shallower water. The "sciaja" or enclosures are on the eastern side of the bay, at a little distance from the Stagnoni shore, and consist of rectangular spaces, enclosed and crossed by four or five rows of stout piles of pine wood—sometimes coated with pitch—driven into the bottom of the sea, and emerging about three feet above the surface. These piles are connected together by ropes of grass from which the strings of oysters (known as "pergolari") hang. Close to the tops of the piles short branches are attached obliquely, pointing outwards, from which thick nets are hung that completely surround the "sciaja," and prevent predatory fish destroying the oysters. There is also a "sciaja" at La Grazie Cove, on the western side of the bay. Latterly an innovation has been introduced in the method of suspending young oysters in the fattening enclosure ("sciaja"), and this consists of placing cement between two layers of oysters, each layer having two oysters, making a group of four oysters. These groups thus stuck together are inserted into the strands of the rope, one above the other at short intervals, and suspended in deep water; this prevents any of the oysters being washed away and lost. One thousand oysters are estimated to weigh 40 or 50 kilogrammes (say, about one hundredweight). The average prices at which oysters are sold are—first quality, 32s. per thousand; second quality, 20s. per thousand; and third quality, 13s. per thousand. The industry has suffered somewhat from a rumour spread in the neighbourhood that the oysters contained the germ of typhoid. This led to investigations by order of the sanitary authorities at Rome, and the publication of a report stating that there was no ground for the rumour.

THE FIBRES OF THE PHILIPPINE ISLANDS.

By far the most important of the fibre plants growing in the Philippines is Manila hemp, or *abacá*. At first sight this plant might be taken for an ordinary plantain, or banana tree, but its fruit is much smaller than the banana, and is not edible. According to a recent report of the United States Department of Agriculture, the Manila hemp crop comes chiefly from the provinces of Albay and Camarines, on the island of Luzon and from the islands of Marinduque, Leyte, Cebu, Mindoro, Samar, Mindanao, and the southern part of Negros. The finest quality of the fibre is called "lupis," or "quilot," and is of a pearly lustre. Other grades are distinguished by their colour and consistency. Nearly the whole crop is placed on foreign markets. The average yearly shipments amount to nearly 1,000 tons, and form the most important item in the Philippine export trade. The United Kingdom and the United States receive the largest shipments, although considerable quantities are also sent to Spain, Australia, China, and Japan. Cotton occupies a peculiar position in the Philippines. It was the first raw fibre used locally in the manufacture of textile fabrics, but it has recently lost much of its former importance, partly because of the excessive taxation that has for some time been imposed on the textile industry of the islands, but principally because of the competition of British fabrics. The cotton plants cultivated in the Philippines are chiefly of the herbaceous varieties. They yield a fine white staple, of superior quality and strength. One variety, however, known under the name of *cayote*, produces a cinnamon-coloured fibre. There is also a species called *bubuy*, that grows like a shrub; the fibre it produces cannot be employed in weaving, but is used in stuffing mattresses, pillows, cushions, &c. Another textile plant that occurs is the *amiray*; this plant is found only on the Batanes Islands, north of Luzon; it closely resembles ramie, and yields a fine white fibre of great tensile strength. Various other fibre plants are found in the Philippines, such as the *pita* (a kind of aloe), the *balibago*, the *dalanot*, or tree nettle, the pineapple, and the *cabonegro* (a species of palm tree), as well as many other varieties more or less unknown outside the archipelago.

POULTRY BREEDING IN BELGIUM.

The breeding of all kinds of domestic animals, for profit or pleasure, was for centuries more advanced in Belgium than in any other European country. Poultry is bred throughout Belgium—in some localities for eggs and meat—in others for meat alone. According to the United States Consul at Brussels, the breed most in favour for general purposes is known as the "Land Van Orlst." The hens, somewhat resembling the pencilled Hamburg, are prolific layers. The eggs are large, of good flavour, and produce the earliest "poulet au lait," which is marketable when six weeks old, or, when grain fed, at three months. The young cocks mature early, and become fat before three months old, or they are kept at liberty on the farm until after the New Year, and sold during the months of January, February, and March at high prices. Large quantities of eggs and young fowls are exported to the cities of Northern France. The breed *par excellence* for the table is the "Conconde Malines," better known in trade as "poulet," or "poularde de Bruxelles." When the chicks are about three months old they are put in coops of special construction, preparatory to fattening for market. The coops or cages are 24 inches high, 20 inches wide, and stand upon four legs, 3 feet in height. The bottom is made of laths, and the top is an adjustable board, to allow the free circulation of air. The

front consists of laths, placed at a distance of from 2 to $2\frac{1}{2}$ inches apart. The receptacle for food is a triangular-shaped wooden box. Each coop accommodates about twenty chickens. After the fattening period expires the coops are thoroughly cleaned, and exposed to the air for not less than fifteen days before receiving other chickens. The length of time necessary to fatten varies from four to five weeks. The best age for fattening is when the chicken is from three to three and a half months old. Younger than this they cannot endure captivity, and when older they cannot become accustomed to it. The food consists of ground buckwheat, mixed with milk, forming a kind of paste, not too liquid, which is given twice daily, very early in the morning, and at about four o'clock in the afternoon. About noon, pure milk, or milk mixed with a little water, is given. If the fowls refuse to take the food they are not forced to eat, but are removed from the coop and killed, otherwise they grow thin and lose their market value.

General Notes.

Chinese Coins.—The collection illustrating the coinage and currency of the Chinese empire, brought home by Lord Charles Beresford from his recent mission to China, has been lent by him to the Victoria and Albert Museum, South Kensington. This collection includes a series of silver taels of various sizes, in the form of cast ingots in the rough, with a pair of scales, with brass and ivory weights for estimating the value, and some fragments used as small change. There is a set of dollars of different nationalities which pass in China, among them being the new British dollar, first issued in 1898, and coined in India. Among the copper coinage is a collection of 10,000 cash, strung together in bundles by means of the central hole which is a characteristic of Chinese copper coins, representing £1 in English money. This exhibit has been placed in the Chinese Section in the Cross Gallery, behind the Imperial Institute. The entrance to this gallery is through the Indian Section, Victoria and Albert Museum.

Indian Tea.—The Indian Tea Association of Calcutta have recently published detailed figures showing the distribution of tea from Calcutta to various places outside the United Kingdom, thus affording an amount of information which, if taken advantage of, may lead to the development of some new markets. The total shipped to these markets was 18,657,841 lbs. 1898-9, against 14,532,618 lbs. 1897-8. The most important places where Indian tea goes direct are shown in the following list (in lbs.), and in addition to the large markets of Australia, "Indian Ports," and North America, Turkey has taken a considerable quantity, as well as Persia, Arabia, Germany, and Russia. The destination of the large quantity headed "Indian Ports" is not precisely known, but probably a large proportion of it goes from Bombay to some of the Asiatic markets in the neighbourhood of the Persian Gulf:—Australasia 6,293,950, Indian Ports 3,919,018, N. America 3,232,027, Turkey 1,994,507, China 883,295, Germany 526,418, Persia and Arabia 1,504,845, Russia 49,958, Egypt 127,946, Straits Settlements 34,299, Africa 34,436, France 26,294, Norway 8,480, S. America 1,000, Austria 4,145, other places 17,223, total 18,657,841 lbs.

Electric Lighting in Brussels. — Statistics show that in 1893, 3,030 lamps met the requirements of consumers of electricity in the city of Brussels. At the present time, according to Consul Roosevelt, there are 66,000 lamps. In consequence of the constantly increasing use of electricity, the city has been obliged to enlarge its works. It is now proposed to acquire five new vertical machines of 1,000 horse-power to be placed in works already supplied with five horizontal machines of 500 horse-power. The city also has electrical works established in the railway station, but owing to the steadily increasing use of electricity, the production is insufficient to meet public demands. It was at one time proposed to erect a large electrical power-house just beyond the city limits; but, as it was shown that about 15 per cent. of the current would be lost, the proposition was rejected. The most practical method now seems to be the creation of new stations as the exigencies of the situation may demand.

Military Motor Cars.—The *Times* describes a motor vehicle for military purposes, designed by Mr. Frederick Simms. This "motor scout," as it has been named, consists of a quadricycle fitted with a $1\frac{1}{2}$ horse-power petrol motor, which can propel it at any speed up to about 18 miles an hour for a distance of 120 miles, or further with a reserve supply of petrol. It is convertible, carrying either two persons or one person and a light Maxim gun. In the latter case, the gun is mounted in front over the leading wheels and so arranged that it can be fired either to the right or left or straight ahead with the vehicle going at full speed, while in a tray below there is room to store 1,000 rounds of ammunition within easy reach of the rider. Another type of "war motor car" designed by Mr. Simms is much larger and heavier, is armour-plated all over, and has a ram both in front and behind. The armament consists of two quick-firing Maxim guns, carried in two revolving turrets. The steering is managed by means of mirrors, and it is claimed that the crew need never expose themselves outside the protection of the armour. An electric search light is provided, the dynamo being worked from the main engine (16 horse-power nominal). The tires with which the wheels are fitted are such as will enable the vehicle to travel over very rough ground. A third type designed by Mr. Simms is a military railway inspection car, also armour-plated and carrying a Maxim gun. All three vehicles are built to the order of Messrs. Vickers, Sons, and Maxim.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS.

The results of the Examinations held at the end of last March have been published.

Copies for gratuitous distribution to each candidate who attended the examination have been sent to each centre. Additional copies can be obtained, price 6d. each.

The dates for the Examinations in 1900 will be Monday, Tuesday, Wednesday, and Thursday, March 26th, 27th, 28th, and 29th.

Proceedings of the Society.

CANTOR LECTURES.

BACTERIAL PURIFICATION OF SEWAGE.

By Dr. Samuel Rideal, F.I.C.

Lecture III.—Delivered January 30, 1899.

Almost all of the processes for sewage treatment already described have been of a mixed or compound character, and not purely bacterial. And to a great extent this accounts for the numerous failures, either through expense, or irregular working, with such a variable liquid as sewage. Even when it was recognised that nearly all the destruction of effete matter was accomplished by minute organisms, there was a natural reluctance to trust entirely to the action of bacteria, from fear of the multiplication of pathogenic forms. Numerous attempts have consequently been made to sterilise sewage by chemicals, or heat, or electricity, or else to reduce the amount of solid matter by precipitants or filtration. The result of such treatment was a double product; first, an effluent, soon becoming putrid, owing to the subsequent inevitable entrance of more bacteria; secondly, a mass of sludge that required a further expensive treatment. The Royal Commission of 1882-84, after deciding against the discharge of crude sewage into any portion of the Thames, had prescribed "some process of deposition or precipitation, the solid matters to be applied to the raising of low-lying ground, or to be burnt, or dug into land, or carried away to sea." The latter course was resorted to as the only one that was thought available for London. In the case of towns like Bradford and others, at a distance from the sea, this course would be obviously impossible.

The one-acre filter at Barking is still only a part of a process that includes also the cost and complication of a preliminary precipitation, and a subsequent transport of the sludge to the mouth of the Thames. The mixture of chemical and mechanical treatment is even now in practice in a large number of places.

If we recall what was said in our first lecture as to the cesspool, it will be remembered that the natural process consisted in :—

1. Liquefaction of the insoluble matter, and modification of the dissolved matter, in a closed space, therefore mainly by anaerobic bacteria.

2. Oxidation afterwards by the help of aerobic bacteria during passage through a porous medium like land. We have seen how an active smaller area, such as that of a coke or ballast bed, can be substituted with economy and more regular working for at least a part of the necessarily large area of land.

I have always been of the opinion, and have often urged in previous papers, that the anaerobic change is an integral part of the preparation, and that the neglect, and even avoidance of it, has been a frequent cause of failure. As Rudolph Hering aptly remarks, "The aerobic process, when applied to organic matter in suspension, is slower than the anaerobic process. It takes a long time for solid particles of organic matter to disappear as such, when the conversion depends on the oxygen contained in the water. It takes a short time when it is brought about by anaerobes, which produce conditions causing liquefaction. The reverse seems true in the case of organic matter in solution, because the aerobic bacteria, and conditions favouring a thorough aeration of liquid sewage, will remove a much greater amount of organic matter from the water in the same time than if it is left to the action of anaerobes."

Therefore, the processes should be properly and systematically conducted in natural sequence. Any mixing or confusing in the

order, any artificial interference, or attempt to work distinct reactions simultaneously in the same receptacle, will lead to uncertainty and irregularity in the results. I shall have again to revert in my last lecture to this principle of differentiated bacterial action. At present we have mainly to deal with the preliminary anaerobic liquefaction.

It has long been known that in the slow filtration of sewage, more particularly when the direction was upwards, so that little or no mixing with air occurred, very considerable changes in the organic matter were brought about, entirely unconnected with oxidation. Thus in an experiment of Frankland's as early as 1870, when a strong London sewage was made to traverse, "continuously upwards so as to exclude aeration," a layer of sand, the analysis of sewage and effluent given is the more instructive as the meaning of it was not understood at the time.

PARTS PER 100,000.

	Crude sewage.	Effluent.
Solid matters in solution	64·5	80·5
Organic carbon	4·39	3·23
Organic N.	2·5	1·4
NH_3	5·5	4·6
N as nitrites and nitrates	None	·328
Total combined nitrogen	7·0	5·5

That is to say, the anaerobic bacteria have acted in the usual way :—

1. They have dissolved 16 parts per 100,000 of the solid matters or sludge, thereby increasing the solids in solution from 64 to 80.

2. Some of the ammonia has been changed into, almost certainly, *nitrite*.

3. 1·16 parts of carbon (25 per cent.) and 1·5 parts of nitrogen (60 per cent.) have been eliminated as non-ammoniacal gases, methane, N, and nitrogen oxides, with probably some CO_2.

We shall see later that this is exactly the process that goes on in the Exeter septic tank. In Frankland's filter the arrested suspended matter slowly disappeared just in the same way as organic substances do when dug into the ground or buried beneath the surface. The action at first is simply a process of *hydrolysis*, or combination with water, whereby the complex organic molecules of insoluble organic matters, like fibrin or cellulose, break up and dissolve as simpler compounds, with at the same time a liberation of much of the carbon and nitrogen in the form of various gases. And this first, or preparatory, stage, not only goes on without the presence of air or oxygen, but is actually hindered by it, that is to say, it is effected by the agency almost entirely of anaerobic microbes.

I find that a certain amount of confusion is likely to arise from the application of the words aerobic and anaerobic in two slightly different meanings—one with reference to the chemical changes that occur, the other with regard to the organisms that produce them. The words simply meaning "living with air," and "living without air," the chemist has applied the term "anaerobic" to changes occurring by life in which free oxygen took no part, simple changes by hydrolysis, or the addition of water, like that of urea into ammonium carbonate, of sugar into alcohol and CO_2, or of albumen or cellulose according to the anaerobic equations we shall presently meet. In this sense, the word "anaerobe" implies an organism that effects its changes in surrounding matter without oxidation. But a bacteriologist often uses the term, anaerobe, in the sense of "obligate anaerobe," *i.e.*, one that not only does not require oxygen, but is actually inhibited, or even killed, by its presence. The obligate anaerobes, as is shown by our table of bacteria in sewage, are, though exceedingly active, comparatively few. The "facultative" anaerobes on the other hand, those that can live either with or without oxygen, are much more numerous, as being the ones most suited to a liquid which contains little or none of the gas, but may at any time become oxygenated. Thus yeast, which was classed by Pasteur as "both an aerobian and an anaerobian," *i.e.*, as facultatively anaerobic—when in presence of excess of oxygen multiplies vigorously, but does not act as a ferment, whereas in sugar solutions containing no oxygen, it multiplies with less activity, but the fermentive character is most marked, the yeast attacking the sugar, and obtaining any oxygen it requires from it, or from the water present. Boussingault found that normal fermentation could be carried on *in vacuo*, and was greatly promoted by removing the CO_2 and alcohol as fast as they were formed, and thus preventing their retarding action. In the same way with bacteria, a better result is attained when the liquid products are continuously removed, as in the bacterial tanks of Cameron and Moncrieff, and the nitrifying trays of the latter, than where periods of stagnation occur, as in the intermittent system.

In a paper I read, published in the *Journal*,* I described in detail the chemical processes involved in the transformations, so far as they were known. As even now these are often not sufficiently kept in mind, I may recapitulate some of the main points, with a few later observations.

After remarking that the anaerobic changes occurred naturally in the mud-banks of estuaries, under the surface of the water of rivers, and at the bottom of stagnant pools, where the well-known "marsh gas" (mainly methane, CH_4) is produced, I observed that "in nearly all cases of destruction of organic matter this preliminary disintegration takes place before the final oxidation of the elements." I need hardly remind you that *hydrolysis*, or the breaking up of bodies by the action of water, is familiar in chemistry—and that it frequently results in the dissolving of matters previously insoluble, as in the conversion of starch or cotton fibre into dextrin and sugar, or of solid albuminoids like animal fibre or horn into various soluble products, with or without the assistance of acids, alkalies, or heat.

Very similar changes, mainly hydrolytic, are accomplished by the large class of organic substances called "enzymes," which, though not living, are products of animal and vegetable life. These enzymes have been defined by Lehmann and Neumann as "chemical bodies, which in minimum amounts and without being used up are able to separate large amounts of complicated organic molecules into simpler, smaller, more soluble and diffusible molecules." The definition is not quite accurate, as the milk ferment, for instance, actually coagulates casein, or renders it insoluble, but it gives an idea of the immense power that these enzymes possess, and the economy of their use as distinguished from ordinary chemical or mechanical means. Their importance to us is shown by the fact that a large number of them are the products of bacteria or other fungi, and are powerful agents in their resolving action. By their means a bacillus is not only able to act in its immediate neighbourhood, but also at a considerable distance, through the soluble ferments it forms and disengages. To most of them the termination "*ase*" is applied, as *diastase*, *glucase*, or generally *amylases*, which decompose starch; *lipase*, which hydrolyses fats; *cytase*, which dissolves cellulose, and probably numerous others, which are generated by organisms, and take part in the preliminary liquefying changes of sewage. For example, the enzyme (Rideal and Orchard, *Analyst*, Oct., 1897) produced by *Bacillus fluorescens liquefaciens*, when separated from the organism by a Pasteur filter, is capable of causing liquefaction of gelatine. Dr. Armstrong distinguishes between *zymosis*, or fermentation of organisms, and *enzymosis*, or change by enzymes or unorganised ferments. By the aid of the latter, bacteria are able to produce effects which are quite out of proportion to their size or even to their numbers. Enzymes are also developed by moulds and other fungi.

* *Journal*, vol. xlvi., p. 81, December 17, 1897.

It must be repeated that these phenomena of resolution take place independently of the presence of oxygen and even more rapidly in its absence, and that even where the organic matter is partly converted into final stable oxidised compounds, the oxygen of the latter is not derived from the air, but is that which was originally present in the organic matter, or in the water taking part in the reaction.

I have previously instanced as a type of anaerobic hydrolysis, the case of albumen. Summing up all the changes in one equation, and taking the simplest empirical formula, we should have :—

$$4C_8H_{13}N_2O_3 + 14H_2O = 4N_2 + 19CH_4 + 13CO_2 + 2H_2,$$

giving us all the gases which are commonly met with in these decompositions, and *leaving no residue of solid matter*.

But the large amount of hydrogen that is liberated shows that there is an oxidation *at the expense of the oxygen of the water*. Thus I have found the gas evolved in the septic tank at Exeter to have the following composition :—

	Per cent. by volume.
CO_2	0·6
CH_4	24·4
H	36·4
N	28·6
	100·0

This is very similar to the fermentation described by Wood and Wilcox as produced by *Bacterium furfuris* in the manufacture of leather. This bacterium does not attack cellulose, but only starch and nitrogenous matter. They found a sample of the gas evolved to contain :—

CO_2 and traces of H_2S ..	25·2	per cent.
Oxygen	2·1	,,
Hydrogen	46·7	,,
Nitrogen	26·0	,,

Formic, acetic, butyric, and lactic acids were produced. These in sewage would combine with ammonia. I have lately found in a septic tank effluent salts of acetic, butyric and phenylacetic acids.

On the other hand, *Bacillus amylobacter*, which is strictly anaerobic, dissolves cellulose and evolves gases, the equation being given by Hoppe Seyler as—

$$C_6H_{10}O_5 + H_2O = 3\ CO_2 + 3\ CH_4.$$

The greater part of the carbonic acid remains dissolved as carbonate of ammonia, while the hydrogen, from its easy diffusibility, escapes from the tank more rapidly than the heavier gases. No sulphuretted hydrogen was found in the septic tank gases, the sulphur remaining in solution mainly as methyl mercaptan, $CH_3\ HS$. The normal decomposition of urea into carbonate of ammonia and water is an example of a simple hydrolysis which produces no free gas, thus:—

$$CH_4\ N_2O + 2H_2O = (NH_4)_2\ CO_3.$$

The following Table shows the weight of oxygen required to convert some typical organic compounds into the final products that are actually found:—

Substance.	Empirical formula.	Per-centage composition.				Oxygen required by one part to convert it into—	
		C	H	N	O	CO_2, H_2O, & N	CO_2, NH_3, & H_2O
Albumin	$C_8H_{13}N_2O_3$?	53·4	7·1	15·8	23·7	1·754	1·48
Gelatin	—	50	6·6	15·3	25·1	1·61	1·33
Starch, cellulose, and woody fibre	$C_6H_{10}O_5$	44	6·2	—	49·4	1·184	1·184
Ammonium amidoacetate (Ammonium salt of glycocine)	$C_2H_8N_2O_2$	26·1	8·76	30·43	34·78	1·043	0·53
Urea	CH_4NO_2	20	6·7	46·7	2·66	0·803	0·

Every eight parts by weight of oxygen absorbed from water would involve the liberation of an equivalent, or one part by weight of hydrogen, so that the above weights, if increased by one-eighth, give the weight of water taking part in the hydrolysis. At present it is difficult to say whether the first or second of the transformations given in the last two columns should be encouraged. As a matter of fact, both usually occur in practice.

It is obvious that the first or more complete change is one in which the gases evolved would be entirely without odour, but the N, being in the free state, is lost: in the second or less complete anaerobic change, the gas will have an ammoniacal odour, and would be offensive if allowed to escape into the air. The effluent also will contain combined N in the form of NH_3 and compound ammonias, and make it absolutely necessary to insure that adequate nitrification should follow. The final effluent then theoretically contains all the original organic N in the form of nitrate, which is available for plant nutrition.

The "by-product" of these re-actions is a varying but small quantity of dark pulverulent matter resembling the humus or peaty substances of soil. This mixture of bodies of somewhat indefinite constitution, although containing nitrogen, is innocuous from its very stability. It partially subsides and gradually disappears, while the suspended portion may cause turbidity and colour in the liquid, which are removed in the subsequent oxidation by porous aerobic media.

As compared to the voluminous "sludge" of chemical or mechanical treatment, the anaerobic liquefaction leaves only a small quantity of this earthy matter which requires no special provision.

The "cesspool" or anaerobic preliminary treatment is however by no means novel, as it is on record that an early attempt was made in France to carry out systematically this form of treatment. Rudolph Hering has given an abstract of an article in the "Cosmos. Les Mondes" of December, 1881, and January, 1882, on the "Mouras Automatic Scavanger," described as a "mysterious contrivance," which has been used for 20 years, or since 1860. It consists of a closed vault with a water seal, which "rapidly transforms all the excrementitious matter which it receives into a homogeneous fluid, only slightly turbid, and holding all the solid matters in suspension in the form of scarcely visible filaments. The vault is self-emptying, and continuous in its working, and the escaping liquid, while it contains all the organic and inorganic elements of the fæces, is almost devoid of smell, and can be

received into watering carts for horticultural purposes, or may pass away into the sewer for use in irrigation." As to the theory of the action, it is said, "May not the unseen agents be those vibrions or anaerobies which, according to Pasteur, are destroyed by oxygen, and only manifest their activity in vessels from which air is excluded"?

Observations with a glass model showed that "Fæcal matters introduced on August 29th were entirely dissolved on September 16th, while even kitchen refuse, onion peelings, &c., which at first floated on the surface, descended after a time and awaited decomposition. Everything capable of being dissolved acted in a similar way, and even paper wholly disappeared."

It is further said, "The principle on which M. Mouras bases the action of his machine are that the animal dejecta contain within themselves all the principles of fermentation or of dissolution necessary and sufficient to liquefy them, and to render them useful in their return to the soil, and without appreciable loss."

A later article of January, 1883, by the Abbé Moigno gives formulæ for the dimensions of the tank, estimating its superficial area as preferably 1-10th metre, or about 1 square foot per person. The Exeter tank, I may remark in passing, works out to about 0·6 square feet per person. The article also specifies that "for the complete solution of the floating solid matter a period of thirty days should be allowed," giving $\frac{130}{30}$ M as the the total average amount of suspended matter present in the tank at any instant when M is the weight of organic matter present in the volume of sewage dealt with per day. The size of the tank required is therefore not so large as to be impossible with sewages containing an ordinary amount of organic matter, but as the effluent from such a tank without further nitrification has practically all the properties of liquid sewage, it probably accounts for the fact that the "Automatic Scavenger" did not attract more general attention at the time. Mr. Scott-Moncrieff's early experiments seem to have originated from his observation of the rapid liquefaction of organic matter in long lengths of sewers. He began on a practical scale in 1891 by constructing at Ashtead a bacterial tank into which the crude sewage was admitted from below and gradually passed upwards over the surfaces of a bed of stones. He found that the liquefaction of the solids was so effective that the whole sludge of seven years from a household of ten persons was absorbed on nine square yards of land, causing no distinction in appearance between this soil and that surrounding. The space beneath the under grating of the tank had a capacity of less than five cubic feet, and would obviously have filled up in a short time but for the liquefying action that had taken place.

In 1892 his process was examined by Dr. Houston, and later by Dr. Sims Woodhead and myself. Dr. Houston's report of 1893 is practically the first literature on the purification of sewage as a whole bacteriologically, without deposition or chemicals and with hydrolysis by micro-organisms of the grosser organic matter as a precedent to further treatment, a point which is not mentioned in the Massachusetts reports.

In this way the difficulty of the production of sludge was completely disposed of. I have shown how a great part of this, during or after liquefaction, disappears as gases. It is obvious, however, that the remaining liquid will retain the ammonia which has been produced by the hydrolysis, together with residues of nitrogenous and carbonaceous dissolved matters, so that judged by ordinary standards of analysis, this liquid, in the first stage, will show somewhat large amounts of carbon and nitrogen. As examples of some effluents from Moncrieff's anaerobic tanks, derived from heavy domestic sewages during the early stages of experiments, I may quote the following analyses made by C. G. Groves for the Thames Conservancy, and by myself:—

Parts per 100,000.

Date.	Analyst.	Suspended matter.	Dissolved solids.	Cl.	Ammonia.	Albuminoid NH_3.	Oxygen consumed.
May 7th, 1895	Groves.	Trace.	101·0	10·4	15·0	0·8	5·4
June 1896	Groves.	,,	112·0	21·0	7·0	0·8	3·9
July 1897	Rideal.	,,	191·5	59·4	9·0	0·7	8·2

With reference to the first sample, Groves remarks that it contains *a large amount of easily decomposable nitrogenous organic matter in solution*. This great instability of the organic compounds that come over from cultivation tanks is the principal feature of the process.

With the object of obtaining an oxidized effluent, Moncrieff then duplicated the tanks and used them alternately with periods of aeration and rest. The effluent obtained was clearer, and had less odour, but showed practically no nitrification. That the liquid was ready for natural oxidation was shown by the fact that when at Towcester in 1893, the effluent was passed into a small brook, the water actually became clearer below the discharge than above it. Efforts were then directed towards carrying on this final change within the apparatus. It was first tried to obtain nitrification by passing the effluent through the "nitrifying channels," consisting of half drain pipes joined in line by cement, and filled with coke. But the result was not commensurate, for the reason that the right organisms were not developed. During the transit, the liquid was largely exposed to the light, whereas it is known that the bacteria forming nitrates thrive best in the dark. It was noticed that denitrifying organisms, which are not so sensitive, had actually in some cases reduced existing nitrates, as pointed out by Dr. Houston in the Ashtead experiments. How the difficulty was afterwards overcome by the construction of the nitrifying trays will be described in the last lecture.

Up to this point there was still a belief that hydrolysis and aerobic nitrification could be carried on successfully in the same tank. At Aylesbury air was forced in by a steam jet, with this object in view, but the result was unsatisfactory.

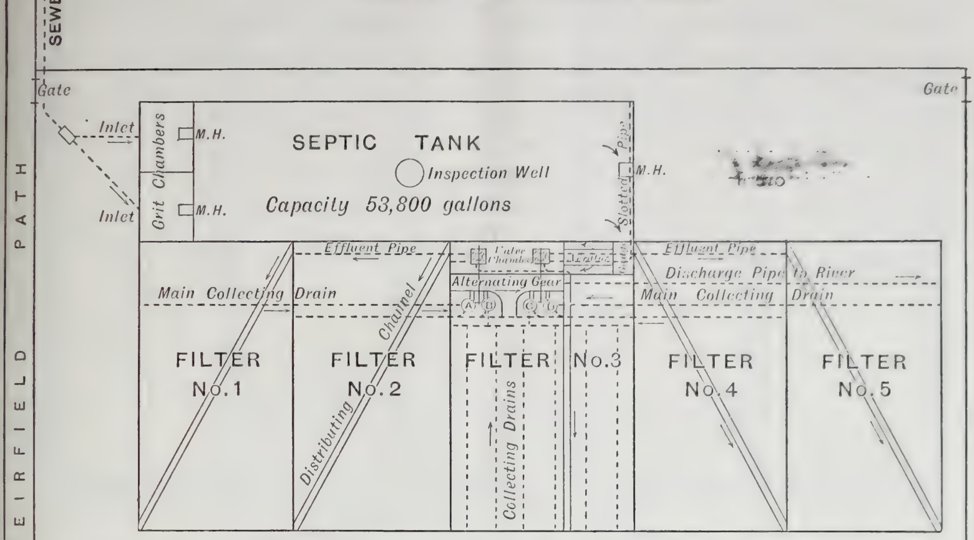
It was concluded finally that all the nitrogenous organic matter must be as far as possible broken up into ammonia before being oxidised to nitrates, and that these two reactions should be carried on in separate areas, the one under anaerobic conditions, and the second with free admission of air but not of light, when the distinctly nitrifying bacteria should be free to work without being interfered with by conditions favourable to other organisms, or by these latter organisms themselves. In very strong sewages there seems almost no limit to the capacity of the hydrolytic ferments to break down nitrogenous matter into ammonia. Thus Marchal found that one of the organisms that effects this function, *B. mycoides*, could thrive in a medium containing two parts in a thousand of caustic potash, equivalent to 660 parts per 100,000 of free ammonia, and in septic effluents in the first stage I have found as much as 30 to 40 parts per 100,000 of NH_3.

But it was found, on the other hand, that there was a limit to the amount of anaerobic change if nitrification is to be carried to a successful issue.

Thus, in recent experiments at Caterham, dealing with a heavy sewage containing 18 parts of Cl per 100,000—the entire discharge from the barracks—the preliminary process was pushed much further than usual, to try if it were possible to carry the anaerobic fermentation too far, with the object of ascertaining the most favourable point, by estimating the free ammonia, and finding what amount gave the best results in nitric nitrogen. Exceptionally anaerobic conditions were introduced, by means of inverted open-mouthed glazed earthen vessels, about 400 in number, piled in a tank 20 ft. by 10 ft. by 9 ft. deep, and kept down by weights. Each pot became filled with gases of the character I have described, devoid of oxygen, so that there were a large number of surfaces on which zooglœa colonies of bacteria could quietly develop in contact with the percolating sewage. The result was an effluent containing 126 parts per 100,000 of dissolved solids, 35 of free NH_3, and 5·3 of organic nitrogen. The liquid was now highly toxic to any but anaerobic organisms, and absolutely refused to nitrify. When diluted, however, with a few volumes of natural water it rapidly became purified.

In 1895, Mr. Cameron, City Surveyor of Exeter, introduced his "septic tank" process for the treatment of a portion of the sewage of the city, comprising about 2,000 persons, on the combined system, yielding about 50,000 gallons of sewage. After passing through a grit chamber where gravel brought down by the rains was detained, the liquid containing all the organic solid matter emerged into a closed tank, through which it slowly passed. The details are well known and are indicated in the illustrations. (Fig. 1.) The present tank has a capacity of 53,800 gallons, therefore holds approximately a day's supply, hence the time of remaining in the tank is about twenty-four hours. In this way the sewage becomes mixed and averaged, and the bacteria have a chance of working during the passing through the 65 feet length of flow, which the sewage

FIG. 1.—SKETCH PLAN OF THE SEPTIC TANK PLANT AT BELLE ISLE FOR DEALING WITH SEWAGE OF ST. LEONARDS, EXETER.



Area of each filter, 80 square yards; and depth 5 feet = volume 22,500 gallons.
Effluent introduced at start = 0·6 of above volume ∴ 0·4 of original volume = coke.
Effluent introduced in ordinary working from 8,000—9,000 gals. per filter.
A, B, C, D are collecting wells, receiving filtered water from the four filters in use.
By means of the alternating gear, each filter in rotation is filled, discharged, and aerated automatically.

traverses at the rate of a little more than 2 feet per hour. No obstruction is present, and the entire space is available, differing from what we have seen of tanks partially filled with stones or coke. In the latter the dimensions must either be larger in proportion, or the sewage must pass at a greater rate, the bacteria also are not so freely distributed through the liquid. From the inspection chamber it is seen that a leathery scum from 2 to 6 inches thick, according to the position, collects on the surface and renders the whole anaerobic. Below this is a zone of fermentation, in which the sewage is mainly clear, but bubbles of gas keep the liquid in a state of quiet admixture. At the bottom of the tank there is a layer of the dark peaty matter, previously referred to, which is so small in amount that during a period of a year's working, it does not require to be removed. The organic matter in it is gradually broken up by the bacteria, the inorganic matter is raised by the gases and gradually carried off in the flow, so that its quantity does not sensibly increase. On October 13th, 1898, I found this peaty matter to contain about 68 per cent. of mineral, 32 per cent. of organic matter, and 2·4 per cent. of nitrogen.

According to Adeney's researches it seems to be necessary for the subsequent nitrification.

The flow through the tank is continuous, therefore requires no attention for Sundays or night. The inlet and outlet are submerged so as to minimise the disturbance of the contents. At the far end of the tank a transverse iron pipe, about a foot below the level of the liquid, with a slot on the under surface extending its length, forms an exit for the effluent, which passes over a V-gauge, and then falls in a thin stream over an aerating weir, to restore aerobic conditions. It then flows through distributing channels on to filters of coke breeze or clinker similar to those at Barking and Sutton, four of which are used at a time, and one kept in reserve. An automatic gear devised by Mr. Cameron regulates the cycles of filling, resting full, emptying, and aeration, so that here again no attention is required. (Fig. 2.) The Local Government Board inquiry of 1897 approved of the system being applied to the whole of the city, of a population of 46,000, with the usual proviso as to land. The daily flow is 1,064,610 gallons, and for this, six tanks 181 ft. by 35 ft. by 7 ft. deep, with a capacity of 262,422 cubic feet, will be provided, in which the suspended solids will dissolve. Eight filters of a total

FIG. 2.

Cycle for Four Filters, Nos. 1, 2, 3, *and* 4, *Discharging into Four Collecting Wells*, A, B, C, *and* D.

At starting, let filter No. 4 be already full and resting, and No. 1 filling.—Period I.

When No. 1 fills, it overflows into tipper C, discharging No. 4, putting down outlet valve of No. 3, and admitting effluent to No. 3.—Introducing Period II.

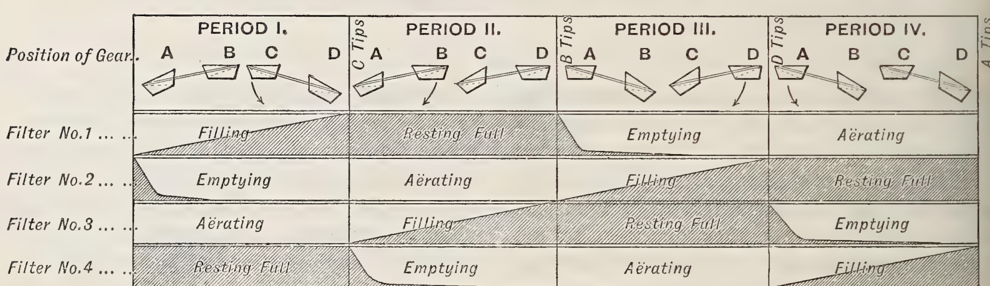
When No. 3 fills, it overflows into tipper B, discharging No. 1, putting down outlet valve of No. 2, and admitting effluent to No. 2.—Introducing Period III.

When No. 2 fills, it overflows into tipper D, discharging No. 3, putting down outlet valve of No. 4, and admitting effluent to No. 4.—Introducing Period IV.

When No. 4 fills it overflows into tipper A, discharging No. 2, putting down outlet valve of No. 1, and admitting effluent to No. 1.—And so on.

Diagram of Overflow Pipes.

Diagram showing
successive states of Filters corresponding to successive positions of alternating gear:-



area of $2\frac{1}{2}$ acres, or 13,600 sq. ft. each, having a depth of $3\frac{1}{2}$ ft. of crushed furnace clinker on 6 in. of coarse gravel, and a working capacity of $2\frac{1}{2}$ million gallons a day, operating with the alternating gear as before, will deal with the tank effluent. (Fig. 3.)

It will be seen that Mr. Cameron, like Mr. Scott-Moncrieff, carefully differentiates between the hydrolytic or solution process, and the subsequent oxidation required for final purification. Dr. Sims Woodhead has shown that while the anaerobic organisms are more numerous in the tank, a number of liquefying aerobic organisms are still present, and increase on passing over the aerating weir. The filters are, of course, aerobic.

The changes occurring in the tank are rather complex. Analyses were made by Dupré, Perkins, and myself, in 1896 and at subsequent dates, and by Dibdin and Thudichum, and Pearmain and Moor, in 1897. From these it appears that the total dissolved solids are increased somewhat, but not in relation to the organic *débris* that has passed into solution. A large proportion has undergone the hydrolytic decomposition which we may represent in two forms :—

1. Producing nitrogen, methane, a small quantity of hydrogen and carbonic acid, as in the general equation already given :—

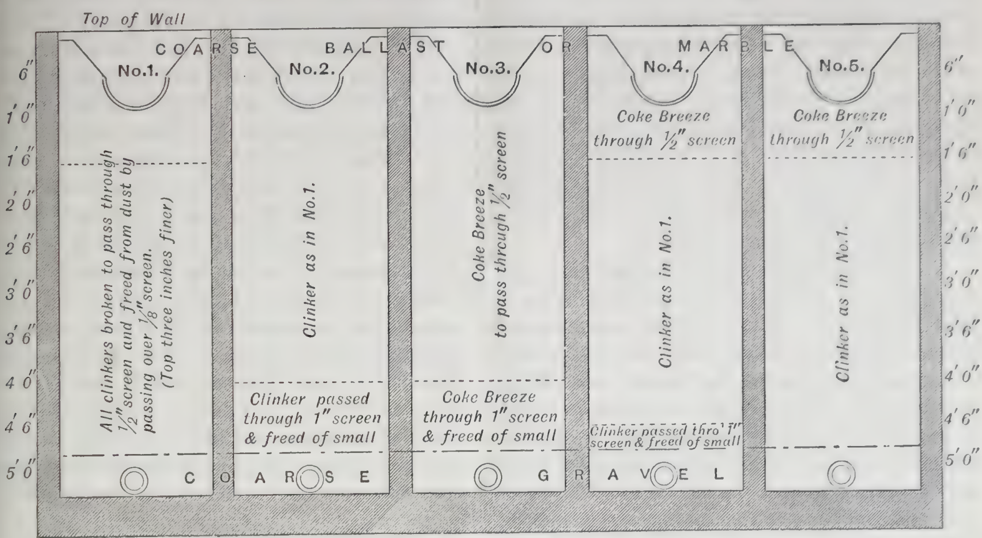
$$4\ C_8H_{13}N_2O_3 + 14H_2O = 4N_2 + 19CH_4 + 13CO_2 + 2H_2$$

2. Producing ammonia, CO_2, and a large quantity of H :—

$$2\ C_8H_{13}N_2O_3 + 16H_2O = 4NH_3 + 16CO_2 + 33H_2.$$

Both species of reactions go on simul-

Fig. 3.—Section Showing Arrangement of Filtering Material at Belle Isle.



taneously, along with others, according to the species of bacteria. The result is the production of a large quantity of inflammable gas, which can be drawn off by a pipe and made serviceable for heating.

The ammonia and the major part of the CO_2 remain in the solution, which contains on an average 33 per cent. more of free NH_3, 29 per cent. less of organic matter as measured by the oxygen consumed, and 46 per cent. less of *albuminoid* ammonia. The organic matter is now in a readily oxidizable state, and passes on to the second or aerobic part, in which it is dealt with by the filters. A large amount of carbonic acid is produced in the filters by oxidation of the organic matters, and is driven out in the stages of filling. I found in one case nearly 7 per cent. of CO_2, which is equivalent to 400 gallons per day. The residue of the nitrogenous matters is mainly changed into nitrates, averaging about one part of nitric nitrogen per 100,000.

The following Table shows the per-centage purification produced by the Exeter process, as stated by different observers at the inquiry in 1897, measured by the reduction of albuminoid ammonia and of the oxygen consumed :—

	Albuminoid NH_3.	Oxygen consumed.
Dupré	84·9	88·3
Perkins	64·4	78·7
Dibdin and Thudichum....	63·2	80·9
Pearmain and Moor	80·0	90·0
Mean	73·6	84·0

My own figures for the separate stages of purification, published in 1896, were, in per cents. of the crude sewage :—

	Albuminoid NH_3.	Oxygen consumed.
By tank	46	29
By filters	31	53
Total	77	82

The installations at Yeovil and other places have proved that the septic tank process is not affected by manufacturing refuse. The smoothing and diluent effect in the volume of sewage, and the room for precipitation and neutralisation by the ammonia, seem to obviate these difficulties.

Three other points in the Exeter Local Government Board inquiry require comment. One was the action of the grit chamber. On entering this the heavy particles of gravel and sand at once sank, while the organic refuse, which in fresh sewage always floats, passed over the submerged wall, 7 feet from the entrance and 12 inches below the surface of the liquid, into the main portion of the tank. The result is that no solid sewage remains in the grit chambers, and the gravel may at intervals be dredged out without disturbing the contents of the tank. This is not at all parallel to the action of screens or straining filters, which also arrest the solid organic matters, thereby forming a subsidiary sludge.

The second point is as to the stay in the tank. The flow of the liquid through the tank in dry weather occupies 24 hours or more, and

in wet weather may be reduced to 7 hours. During that time, it is, as we have seen, profoundly altered by the action of the anaerobic bacteria. But the more intractable portions of the solid matter remain much longer: they are entangled by the active zooglœa scum on the surface, or may slowly sink to the bottom: in both cases they are dissolved by the bacteria and join the liquid, so that the scum and the sediment, though showing some fluctuations, remain about the same volume.

A third important point was raised at the inquiry and is one which requires more than a passing mention. It is as to the pathogenicity of the product after anaerobic treatment, since it has been suggested that whilst cultivating the bacteria necessary for the destruction of the organic matter in sewage, the pathogenic organisms present in the crude sewage will not only survive but may possibly multiply and so cause the effluent to be dangerous to health. It is important, however, to remember that the bacterial processes are not novel, but are identical with those which obtain in nature, so that effluents from sewage farms are strictly comparable with filtrates obtained after either a "coarse bed" or an anaerobic treatment.

Mr. Groves, in his evidence before the Water Commission last week, hoped that the Local Government Board would not depart from their past position with regard to the land treatment, as from the typhoid statistics for London, he argued that the present method of dealing with sewage was satisfactory. Although with any new scheme, it is difficult to obtain any direct evidence as to its ultimate effect upon a river water which is subsequently to be used as a drinking supply, one must recollect that under existing circumstances the removal of all kinds of bacteria from the river water is attempted by those who desire to use such water for drinking purposes, so that even assuming that bacterial systems tend to increase the bacteria in the river, they do not make any new departure necessitating a reconsideration of our methods of water purification. Even if an anaerobic treatment alone resulted in an effluent which possessed toxic properties disastrous to a small river, it must be recollected that no process is at present suggested which does not involve a full and efficient aerating filtration as a final method of purification, and it is the pathogenicity of such filtrates upon which information is wanted. Satisfactory evidence on most of the systems is now available, from which I think we are justified in concluding that even if towns on a river like the Thames adopted bacterial schemes, the pathogenicity of the London water supply would not be adversely affected.

With intermittent fine bed filters following coarse bed or chemical treatment, as at Leeds and London, fish have lived in the filtrates. At Exeter, Dr. Cartwright Wood examined the tank effluent, the filtrate, and the river water before and after admixture. The broth inoculated with these fluids, and incubated for 48 hours, had no effect upon rabbits or guinea-pigs, when 2 c.c. were injected subcutaneously.

When incubated for 11 days, the tank effluent and the water at Belle Isle contaminated with the untreated town sewage, were found to be morbific, but the filtrate and the water at Salmon Pool weir, some little distance below the town, contained so little morbific material of any kind, that even with this severe test both animals remained alive and perfectly well.

Dr. Woodhead, in his report, concludes "that none of the organisms themselves found in the tank effluent are capable, in the quantities present or in which they can grow even in broth, of setting up any morbid changes."

With regard to typhoid fever, Lawes and Andrews some years ago showed that some liquefying organisms have a germicidal effect upon typhoid bacilli, so that their sojourn in a septic tank or their arrest in an anaerobic upward filter, with such organisms diminishes instead of increases their chance of survival. Dr. Pickard, of Exeter, has proved this fact again experimentally by introducing an emulsion of the typhoid bacilli into a septic tank, when he found that instead of increasing they rapidly diminished, until after 14 days less than 1 per cent. of the number introduced were surviving. The same investigator also proved that the filtration was also efficient in removing typhoid bacilli, as he found that filtration as conducted at Exeter removed about 90 per cent. of typhoid bacilli from sewage inoculated with this organism. The passage of a tank effluent containing no typhoid through the same filter yielded filtrates containing only about 1 per cent. of the bacilli introduced in the first filtration, showing that the environment was unsuitable for their development, even if their absence from the filtrate was due partly to a straining action.

Dr. Houston with the Ducat filter has shown that with sewage containing one *B. coli* per 100,000 c.c. a filtrate is obtained which contained no colonies resembling this organism in this quantity. And that sewage containing be-

tween 1,000 and 10,000 spores of *B. enteritidis sporogenes* per c.c., retained after filtration less than 10 per c.c., whilst the aerobic bacteria causing liquefaction of gelatin were likewise reduced from 22 to less than 1 per unit.

In my own work I have proved that the spores of *B. enteritidis sporogenes* survive, as might be expected, the septic tank treatment, but Houston has shown, as stated above, that 99 per cent. can be removed if the tank be followed by a well aerated filter.

Before this evidence of the comparatively innocuous character of the filtrates from bacterial systems was available, I pointed out that subsequent chemical treatment could be used for sterilising the filtrate if necessary. Such reagents as may be conveniently employed may be called "finishers," as the resulting purified sewage is satisfactory, both from chemical and bacterial points of view. Chlorine is one of such reagents, and the late Dr. Kanthack has established the fact that with one grain to four gallons of the tank effluent, or to five gallons of filtrate, with a period of contact of about five minutes, the number of bacteria can be reduced from any number (even millions) to 10-50 per cubic centimetre, and that no pathogenic organisms were found in any of the numerous samples of Maidenhead sewage finished in this way. I found at the same inquiry that on adding 1·77 parts of available chlorine per 100,000, although about half the amount immediately combines with any organic matter present, if the aerating filter has not worked efficiently, the micro-organisms, by contact with the remainder, are gradually killed, so that plate cultivations of such sewage taken after 14 minutes showed no growth with three and a half days' incubation.

Miscellaneous.

THE PRACTICE OF PROFESSIONS IN JAPAN.

Anyone who wishes to practice law in Japan must pass the examination which is held once a year, and must obtain the permission of the Minister of Justice, and then he can practice in the Supreme Court and other Courts. The United States Consul-General at Yokohama says that a minor, a bankrupt who has not completed the obligation of compensation, a person convicted of a theft or fraud, an official, or a public or private *employé* is debarred from obtaining such permission. A practitioner must join a guild of lawyers in the district where he intends to settle, and he must observe its rules aad regulations. The registration fee is 20 yen (about £2), and the sum of 10 yen (about £1) is to be paid as a fee at the time of examination. Violations of the provisions to be observed by the members of its Bar is punishable by censure, by suspension of avocation for not more than one year, or by a fine of not more than 100 yen (about £10). In the case of a graduate of the law college of the Imperial University, he is exempted from passing the examination, but is required only to apply for a license for practising. The profession of veterinary surgeon can be followed only by one who has obtained a licence from the Minister of State for Agriculture and Commerce. Those enumerated below may obtain the licence— One who has passed a verterinary examinarion, and holds a certificate; one who holds a diploma of a Governmental veterinary school, or a certificate that he has passed a special course of the veterinary department of an agricultural college; one who holds a certificate that he has passed a special course of the veterinary department in a public or private school, the curriculum of which has the approval of the Minister of State for Agriculture and Commerce; one who holds a graduation certificate of a governmental or public veterinary school in a foreign country. A licence fee of 1 yen (about 2s.) must be paid; a renewal of licence on account of loss can be made upon the payment or 50 sen (about 1s.). A suspension of business for not less than five days, and not more than 50 days, or entire prohibition of occupation, may be adjudged (if there be any offence with regard to veterinary practice or improper conduct) by the Minister of State for Agriculture and Commerce, according to the circumstances of the case. This prohibition may be rescinded after three years have elapsed if deemed desirable, in which case the practitioner must apply for a fresh licence. A fine of not less than 5 yen (about 10s.), nor more than 50 yen (£5), will be imposed upon one who has practised veterinary medicine or surgery without obtaining a licence. A fine of not less than 2 yen (4s.), nor more than 25 yen (£2 10s.), will be imposed upon one who practices while he is under suspension. A penalty of not less than 1 yen (2s.) nor more than 1·95 yen (about 4s.) will be imposed upon a veterinary surgeon who shall have refused to comply with the request of others for professional services, without sufficient reason for his refusal. The Minister for Agriculture and Commerce may issue a provisional licence to a person who has none of the qualifications enumerated above, but whose antecedents merit such favour, by limiting the area of operation and the period of practice, upon the recommendation of the chief of the Hokkaido Cheo, or of a governor of any prefecture where veterinary surgeons are scarce. Any person who desires to practice medicine must pass an examination before a committee annually appointed by the Minister of State for Home Affairs. The fee for a licence to practice is 20 yen (£2). The alumni of the medical college at Tokyo Imperial University, and

of the medical departments of the first, second, third, fourth, and fifth high schools, and one of the medical schools of Osaka, Kyoto, and Aichi, are entitled to practice without passing the examination, the only requirement being to apply for, and obtain, a licence. A physician who shall have committed any offence, or one who has been guilty of improper conduct in a professional way, may be suspended or prohibited from practice by the Minister of State for Home Affairs, after full inquiry has been made by the central Sanitary Board. After study of at least two years, one who desires to practice dentistry can apply for examination, which is held annually. This must be passed before he can procure a licence, the fee for which is 8 yen (16s.). The penalty clause that applies to physicians is also enforced in the case of dentists. One must be over 20 years of age, pass the examination, and obtain a licence from the Minister of State for Home Affairs, before he can practice pharmacy. The licence fee for practising is 3 yen (6s.). He can make up medicine only in accordance with a prescription of a physician, in which the name and age of the patient, name of medicine, quantity, directions for use, quantity to be taken by the patient, date, and name of the physician, are described. A prescription for a poisonous or astringent medicine must be signed by a chemist and be kept for a period of 10 years. One who practises the business of pharmacist without obtaining Governmental sanction will be punished by a fine of not less than 10 yen (£1), nor more than 100 yen (£10).

Correspondence.

PORT OF CALCUTTA.

In my paper on the "Port of Calcutta" [*Journal*, June 16, p. 628, *et seq.*], I quoted in paraphrase a copy of a letter which Mr. Lindon W. Bates wrote to Mr. Vernon-Harcourt in correction of some statements regarding his Hugli River Improvement Project, made by the latter in an article attributed to an Indian journal. I wrote that "he (*i.e.*, Mr. Bates) says that he has shown it to the engineer, Mr. Franzius, to whose example Mr. Vernon-Harcourt has appealed, and also to the principal hydraulic authority on the Scheldt, and that both those eminent specialists have signified their approval."

I am informed by Mr. Bates that this statement is not correct, so far as Mr. Franzius himself is concerned, and that the project has not been submitted to him personally. The words on which I based my sentence are:—"My Hugli plans have been submitted to the principal hydraulic authority on the Scheldt, and to the authority you quote in Bremen during the past week, and they have given me the assurances of their full approval."

I understood "the authority" in Bremen to be Mr. Franzius. It appears, however, that Mr. Bates, who had discussed the matter with Mr. Franzius' chief of staff in Bremen, intended these words in a less personal sense; they were not meant for publication (as I had supposed) like the special corrections, but to intimate to Mr. Vernon-Harcourt himself that the authorities which he had invoked in his letter to *Indian Engineering* were in fuller accord with his (Mr. Bates's) application of the principles of modern river regulation to the Hugli than with the projects heretofore proposed.

It is, therefore, obviously only just to all concerned that this explanation should be published; and I do so with the approval of Mr. Bates, who has called my attention to the matter, and to whom I have shown this letter.

I desire that the paragraph beginning "I have seen the reply," on the first column of page 644 of the *Journal*, may be considered as cancelled.

C. C. STEVENS.

General Notes.

THE ORIGIN OF FINE PEARLS.—Some hold that fine pearls are the result of a disease in the oyster, and others that they are caused by the shellfish coating intrusive bodies, such as grains of sand, insects, and even small fishes, with nacre, so as to make them agreeable to its soft flesh. According to a paper of M. Leon Diguet, presented to the Académie des Sciences, Paris, recently, there is a distinction between fine pearls and intrusive bodies coated with nacre, which renders both views more or less right. It is true that foreign bodies entering the shell, and probably irritating the mollusc, are coated with nacre, and sold as pearls, often of peculiar and fanciful shape. They occur between the "mantle" and the shell, but are usually, if not always, attached to the shell by a neck of the pearly matter. These "pearls of nacre," as M. Diguet calls them, have not the fine irridescence of the true "Orient" pearl, but only that of the shell or mother-of-pearl. They are the result of an accidental intrusion. On the other hand, the true spherical pearl of Orient lustre is formed in any part of the shellfish except the mantle, and has no connection with the shell itself. It is a pathological calcification or "stone," and seems to arise from parasites. It begins in a small sac of humour, which becomes gelatinous, and calcifies in a series of concentric layers. A pearl thus formed is composed of crystalline matter, and a substance resembling conchioline in alternate layers. At its heart is a cavity holding organic matter and calcareous crystals, with remains of organised creatures, presumably the parasites which have provoked the malady in the shellfish. In course of time the sac in which the pearl is made becomes thin, and the mollusc, breaking it easily, can eject the pearl.—*Times*.

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Proceedings of the Society.

CANTOR LECTURES.

BACTERIAL PURIFICATION OF SEWAGE.

By Dr. Samuel Rideal, F.I.C.

Lecture IV.—Delivered January 30, 1899.

There is an early part of the transformation which we have not hitherto noticed. When fæcal and other solid matters are first discharged, the earliest changes must be aerobic, because of the free oxygen dissolved in the water and contained in the air. The effect is mainly the same as the *last* stage, *i.e.*, the organisms acting in a normal manner upon those simpler constituents like ammonia, which must obviously already exist in small quantities, and into which the process itself afterwards resolves the main ingredients of the sewage. Nitrates in small quantities are consequently often observed in discharges which are moderately fresh.

As soon as the free oxygen has been exhausted, these oxidation changes come to an end, and the bacteria which require air in part disappear, and in part remain quiescent to resume their functions at a later stage. On the other hand, the anaerobic organisms will commence to multiply, the nitrate will be reduced to nitrite and this to nitrogen, according to reactions we shall explain later, and the liquefaction and hydrolysis changes will proceed. This is usually the condition when the sewage arrives at the works, and the first, or anaerobic stage of the treatment proper, commences.

In the second stage, aeration is to be encouraged as much as possible, so that the aerobic bacteria may act, and ammonia and carbonic acid be produced, with the help of some of the anaerobic forms.

In the third stage, with provision of a still larger quantity of oxygen, the nitrifying group will get rid of the remaining products.

The phenomenon of *symbiosis*—that is when one or more kinds of bacteria act together and effect decompositions which neither of them could do separately—shows that it is not necessary to aim at securing individual species, which indeed would be impossible in practice, if the complexity of the flora of sewage be considered.

Dr. Sims Woodhead found in Exeter crude sewage the following number of organisms per cubic centimetre (about 20 drops):—

Anaerobic	Liquefying, 300,000 (some fluorescing and many of them gas-producing). Non-liquefying, 700,000.
Aerobic (facultatively anaerobic)	Liquefying, 500,000. Non-liquefying, 3,000,000 to 5,000,000.

Dr. Houston, in London sewage, finds about 4,000,000 to 5,000,000 of bacteria, of which about 500,000 are liquefying.

On the other hand, in a mixture of species, some are crowded out, and being unable to act, finally disappear. Such is the fate, as we saw in the last lecture, of pathogenic organisms, which preferably grow at blood heat, and do not find themselves under favourable conditions at low temperatures, and among a swarm of competing others.

If, however, successive zones or habitats be arranged under slightly varying circumstances of aeration or otherwise, groups of species will establish themselves to the exclusion of others, and sewage passing through will find itself exposed to a natural cycle of change. Such an arrangement takes place in the top and bottom layers of the septic tank, and still more in the "bacteria tank" of Scott-Moncrieff, where the stones become coated with zooglœa layers of different organisms at successive points. The same system he carries out further in the oxidising filter, to be described later.

This differentiation of the organisms leads us to a consideration of the chemical reactions that occur, and the bacteria which produce them.

The fermentations occurring in the first or hydrolytic part of the process may be chemically classified, as follows:—

1. The solution and decomposition of albuminous bodies.
2. The fermentation of urea.
3. The fermentation of the amido-compounds formed from the albuminous bodies.
4. The formation of organic acids, and the fermentation of their salts.
5. Cellulose or methane fermentation.
6. The hydrolysis of carbohydrates.

7. The formation of small quantities of sulphur compounds, like H_2S, mercaptan, &c. This, from the odour of the products, often attracts the most attention.

These, as a rule, are conducted by bacteria, mould and yeasts not being commonly found in sewage, indeed, their presence, according to Andreasch, is distinctly prejudicial to normal bacterial action.

The following is a list of some of the sewage bacteria which have been found by various observers:—

BACTERIA OCCURRING IN SEWAGE.

NOTE.—L, liquefying gelatine; NL, not liquefying; SL, slightly liquefying.

Obligatory Anaerobes.

Spirillum rugula, L (very active, spore bearing, gives rise to a fæcal odour).

Sp. amyliferum (in absence of air acts as a vigorous ferment).

Bacillus enteritidis sporogenes. (Klein. See Lecture I.)

B. amylobacter, L *(Clostridium butyricum)*.

B. butyricus (Botkin), L (gives much gas).

(*B. subtilis* is aerobic, and rapidly consumes oxygen, so is dormant in the first stage.)

Facultative Anaerobes or Aerobes.

B. putrificus coli, NL (decomposes albuminous substances with liberation of ammonia, whether air is present or not).

Spirillum plicatile, serpens, undula, tenue, and *volutans.*

Vibrio saprophilus, aureus, flavus, fluorescens, NL (in sewer mud).

B. mycoides, L } Produce NH_3 from nitrogenous
Proteus vulgaris, L } organic matter, and denitrify.

B. fluorescens putridus (similar, produces trimethylamine).

B. fluorescens liquefaciens, L, and *non-liquefaciens*, NL. See Lecture I.

Micrococcus ureæ, NL; *B. ureæ*, NL (convert urea into ammonium carbonate, the latter the most energetically). Flügge has also described a *M. ureæ liquefaciens.*

B. mesentericus, L (several varieties in London crude sewage).

Proteus mirabilis and *Zenkeri*, L.

B. megaterium, L; *liquefaciens*, L; *magnus, spinosus.*

Streptococcus liquefaciens coli, L, and *mirabilis*, NL.

B. saprogenes, I., II., III.; *pyogenes* and *coprogenes fetidus.*

B. acidi paractici.

B. lactis aerogenes, NL (produces CO_2 and H).

B. coli communis, NL (produces much gas, mainly H).

Cladothrix dichotoma, L.

Proteus sulphureus, L (produces H_2S and mercaptan).

Bacterium sulphureum, L (liquefies gelatine and casein, produces H_2S). Found by Sims Woodhead in Exeter sewage.

Beggiatoa alba (secretes granules of sulphur, formed, according to Winogradsky, by oxidation of H_2S, and finally turned into sulphuric acid by the plant).

The following forms reduce nitrates to nitrites:—*B. vermicularis, liquidus, ramosus, aquatilis* (grows luxuriously in ammonia solutions), besides *mycoides* and *Proteus vulgaris.*

The following were found by Jordan in the sewage of St. Lawrence, Massachusetts:—*B. cloacæ*, L; *ubiquitus*, NL; *reticularis*, SL; *circulans*, L; *hyalinus*, L: all reducing nitrates. *B. superficialis*, SL, not reducing.

I must content myself with a few comments on some of the species. First, we must notice that as sewage contains little or no oxygen, nearly all these species must be at least facultatively anaerobic, and the decompositions they engender are hydrolytic. Consequently it is a mistake in the first stages to introduce air, which merely hinders the anaerobic changes. Any attempt to induce early nitrification before solution is effected, results in the production of nitrites and not nitrates.* The same non-recognition of anaerobic liquefaction leads to the difficulty with the solids blocking the filters, and to the compulsory resort to screens, sedimentation, or even to an idea of preliminary precipitation, all of which produce their equivalent of sludge. During the "resting full" period of the filters the changes are really anaerobic, during emptying and resting empty the aerobic bacteria are at work. Therefore if sole dependence is made on such filters, the process is a mixed and variable one, and the result is shown in deficient nitration.

The Vibrios in sewer mud do not liquefy gelatine, but act probably on the carbonaceous vegetable matter.

Bacillus ureæ is said to be more energetic in converting urea into ammonium carbonate than the associated *Micrococcus ureæ.*

The putrefactive fermentation of albuminous bodies is caused by a large number of species, of which the forms from London sewage, mentioned in the first lecture, are among the most frequent. The first action is parallel to ordinary digestion, that is the so-called *peptonization*, or conversion into a soluble form. The peptones are then split up, amido-acids like leucin, tyrosin, &c., are formed together with a number of substances of the aromatic group,† the amido-acids further break

* *Bacillus mycoides, liquidus, vermieularis, ramosus, cloacæ* (Jordan) *aquatilis*, and others powerfully reduce nitrates to nitrites, and account for the absence of nitrates in sewage.

† Oscar Emmerling found that *Streptococcus longus*, in liquefying fibrin, produced peptones, and then ammonia,

TABLE OF FERMENTATION OF ORGANIC ACIDS.

(For simplicity the sodium salts are taken though the lime salts are rather more fermentable.)

Salt fermented.	Cause of fermentation.	Products.
Formate	"Bacteria from sewage slime."	Acid sodium carbonate, $NaHCO_3$, carbonic acid and hydrogen.
Acetate	Ditto.	Acid sodium carbonate, $NaHCO_3$, carbonic acid and methane, CH_4.
Lactate .... Undergoes four different fermentations.	"Thin bacillus" (Fitz). "Other species of bacteria; short aerobic butyric bacteria" (Fitz).	1. Propionic acid, and as bye-products, acetic and succinic acids, and alcohol. 2. Propionic and valerianic acid. 3. Butyric and propionic acid. 4. Butyric acid and hydrogen.
Malate...... Different fermentations.	Bacteria, not described; "Thin bacilli."	1. Chief product—propionic acid; bye-product—acetic acid. 2. Chief product—succinic acid; bye-product—acetic acid. 3. Butyric acid and hydrogen. 4. Lactic acid and CO_2.
Tartrate	Different species of bacteria.	1. Chief product—propionic acid; bye-product—acetic acid. 2. Butyric acid. 3. Chief product—an acetate; bye-products—alcohol, butyric and succinic acids.
Citrate	"Small, thin bacilli."	Acetic acid in large quantities, with small quantities of alcohol and succinic acid.
Glycerate ..	Micrococci; medium-sized bacilli.	1. An acetate, with small quantities or succinic acid and alcohol. 2. Formic acid, with some methyl alcohol and acetic acid.

[Under active microbic fermentation all eventually pass into CO_2 and H or CH_4. The CO_2 is partly free, and partly as bicarbonate of the base. Acetic acid is generally the penultimate product, therefore the common production of methane. Any amides of the acids are hydrolysed, with liberation of ammonia].

up into fatty acids and ammonia. Tyrosin yields indol, skatol, phenol, and acids related to benzoic (*Spirillum rugula* and the *B. coprogenes* group develop a strong fæcal odour, probably owing to this reaction).

The breaking up of organic acids is described in the following Table, adapted from a summary of the varieties of septic fermentation, by Dr. E. Herfeldt, of Bonn.*

The volatile bases produced in the fermentations are, in the ordinary method of analysis, put down as "free ammonia," which includes not only the ammonia really existing in the free state, but also that combined with the organic acids as salts, as well as such compound ammonias as react with Nessler test. Many years ago Young pointed out that in the usual mode of distillation, volatile nitrogenous matter escaped which was not recorded by Nessler. I have often also indicated that the conventional procedure in the Wanklyn determination gives an "albuminoid ammonia" far short of the fixed organic nitrogenous matter, which probably accounts for such low figures as 0·34 (with 13·8 of chlorine), 0·24 (with 10·3 of chlorine, &c.), for raw sewages in the recent Manchester and other reports. The Kjeldahl process, on the other hand, gives theoretically the whole of the ammoniacal and organic nitrogen.

In a septic tank effluent I lately found, by fractionation of the hydrochlorides :—

mono- and tri-methylamine, tyrosine, leucine, fatty acids to caproic (except valeric), succinic, and a collidine, or pyridine derivative (Berichte, 1897, xxx., p. 1863).

* "Centralblatt fur Bakt.," Jan. and Feb., 1895; "Journ. Soc. Chem. Ind.," May, 1895.

	Parts per 100,000.
Actual ammonia	3·48
Monomethylamine, CH_3NH_2	0·844
Trimethylamine	traces

the original having given 4·6 parts of "free ammonia," and (by Kjeldahl) 1·98 parts of fixed organic nitrogen, with a chlorine content of 6·2.

Trimethylamine has a fishy smell, which is very marked in some sewages. *B. ureæ*, *B. prodigiosus*, and *B. fluorescens putridus* develop this compound during putrefaction; Amylamine and other volatile bases are also found. The chief importance of the group lies in—

1. Their volatility and odours;

2. Their removing carbon as well as nitrogen;

3. The toxic nature of some to the organisms of nitrification. Therefore—

(*a*) The preliminary liquefaction should be conducted in a closed chamber;

(*b*) The amines must be removed by a nitrous or other oxidation in the second part of the process, before reaching the nitric organisms.

The same remarks apply to:—

The Sulphur Fermentation.—Dr. Sims Woodhead found *Bacterium sulphureum* in the Exeter tank. It liquefies gelatine, casein, and other albuminoids, and produces sulphuretted hydrogen. Several observers did not however find H_2S in the tank gases. I have found that a mercaptan (methyl hydro-sulphide) and other ethereal compounds are undoubtedly present in small quantities. They are very soluble, and fairly easily oxidized.

Most of the sulphur, however, enters into combination with the iron present in the sewage, forming insoluble ferrous sulphide and giving a black colour to the suspended matter. When the black matter is acted on by acids, sulphuretted hydrogen is evolved and the substance becomes brownish, just as when strongly acid effluents from factories are discharged into ditches or on to the black mud banks of neglected rivers, a liberation of sulphuretted hydrogen occurs. In the tank, however, the ferrous sulphide is protected by the ammonia; on reaching the oxidation stage it is converted into a basic ferric sulphate, forming an ochreous coating on the materials, which considerably assists in the transfer of oxygen.

Anaerobic fermentation is called by the Germans *true putrefaction* (Faulniss), while aerobic is termed *mouldering* (Verwesung). In the first, hydrolytic processes, in the second oxidation, prevail.

DISSOLUTION OF CELLULOSE AND FIBROUS MATTERS.

Mitscherlich in 1850 proved that cellulose was dissolved by fermentation, and Van Tieghem in 1870 describes the most active organism as *B. amylobacter*, anaerobic, and derived principally from the intestines of animals. Tappeiner fermented cotton-wool and paper-pulp in a weak nitrogenous solution, and obtained CO_2 and methane in neutral, and CO_2 and H in alkaline solution. Hoppe-Seyler in 1886 found only traces of soluble residues, and concluded that at first a soluble carbohydrate was formed by the action of water, and that this was then split up into carbonic acid and methane—

$$C_6H_{10}O_5 + H_2O = C_6H_{12}O_6$$
$$C_6H_{12}O_6 = 3\,CO_2 + 3\,CH_4$$

If more water took part, less CH_4 and more H would be obtained.

Van Senus in 1890 proved the fermentation of fibre to be anaerobic, that it was occasioned by a symbiosis, or concurrent action of *B. amylobacter* with *butyricus* and other organisms, and that gaseous products of the above character finally remained. He isolated an enzyme which dissolves fibre, and also a group of these "resolving bacteria" from mud, stomach contents, and decaying vegetable matter.

In laboratory experiments with different kinds of cellulose, paper, cotton-wool, &c., in water inoculated with sewage organisms, I have observed gradual liquefaction with the production of inflammable gases.

The changes occurring in silos and in manure heaps, may be noticed as examples of the anaerobic breaking down of cellulose and fibrous matters.

The fragments of vegetable matter which pass down sinks, occasion considerable nuisance when an attempt is made to remove them by screens, or on the top of a coarse filter. They act objectionably in three ways:—

1. They set up acid fermentation and corrode iron.

2. Many of them (*e.g.* cabbage leaves) contain sulphur compounds, and evolve very offensive odours.

3. They form a pulp which blocks the strainers.

Under anaerobic conditions in a closed space

they rapidly rot away and disappear, their pectose first dissolving, and then their cellulose, while the ammonia takes up the acids.

FERMENTATION OF OTHER CARBOHYDRATES.

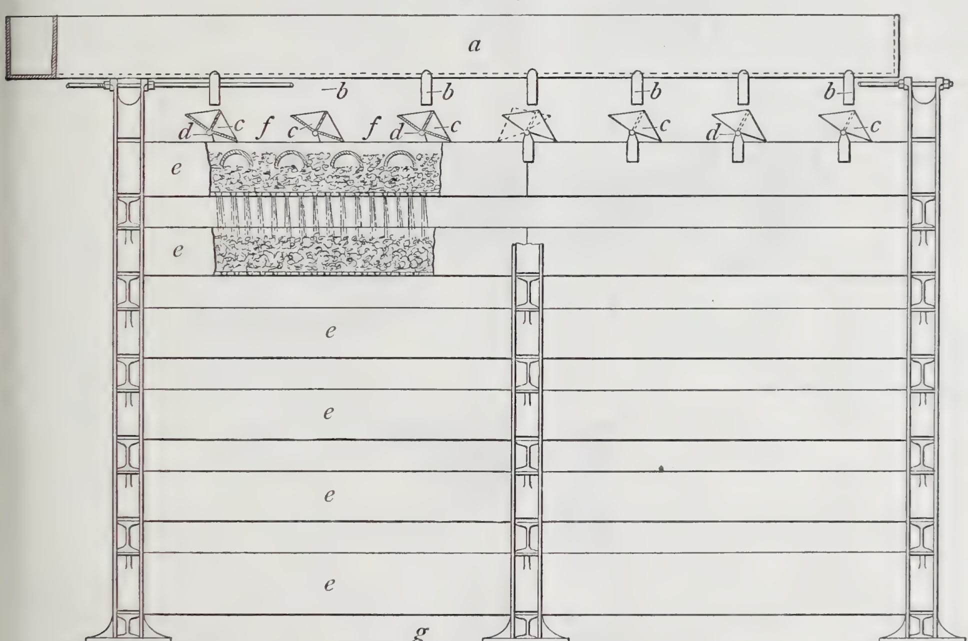
Starch, different sugars, and gummy substances undoubtedly enter into sewage. But their hydrolysis is so rapid, that very little trace of them is found after a short period. Those fermentations, like the alcoholic, which are occasioned by higher fungi like yeasts and moulds, do not present themselves. The changes are mostly lactic, by *B. acidi lactici*; or butyric, by *Clostridium butyricum* or *Bacillus butyricus* (both anaerobic), giving, besides the respective acids, carbonic acid, hydrogen, and water.

DECOMPOSITION OF FATS.

Soap-suds and greasy matters give rise to considerable trouble in the mechanical treatment of sewage. At Bradford the refuse of wool-scouring has been the chief difficulty for years. The sewage has been precipitated chemically by ferric sulphate, but, in addition to the large quantity of chemicals required, and the unsatisfactory character of the effluent, the very large quantity of grease in the sludge obstructs the filter presses, and renders it impossible to reduce the water below 95 or even 98 per cent., which not only increases its weight and bulk, but also the difficulty of drying. The Corporation will eventually follow the example of Leeds, and adopt a bacteriological method.

In a bacterial tank the grease is first emulsified by the ammonia. There are several bacteria that attack fats in presence of nitrogenous substances (Sommaruga, Zeits. Hyg., xvii. 441), breaking them up into the simpler acids of the fatty series, like acetic and butyric, which in their turn are finally resolved into CO_2 and H. Many common moulds also act on fats, notably the ordinary green mould, *Penicillium glaucum*, which Hanriot found to contain an enzyme "lipase," besides emulsine and other ferments. Moulds are not commonly present in the anaerobic stage, but occur in the second, or limited aeration. Ritthausen and Baumann found that a great destruction of fat occurred by the action of moulds and bacteria in a substance containing proteids as well; the substance they experimented on was rape-cake.*

FIG. 4.



There are also ferments existing in fungi and most vegetables, called by Bertrand "Oxydases," which are capable of acting on phenol and the aromatic compounds in the second stage.

We may now summarise the order of the changes as follows:—

* "Landw. Versuchs. Stat.," xlvii. 389, 1896. The subject does not seem to have been much investigated.

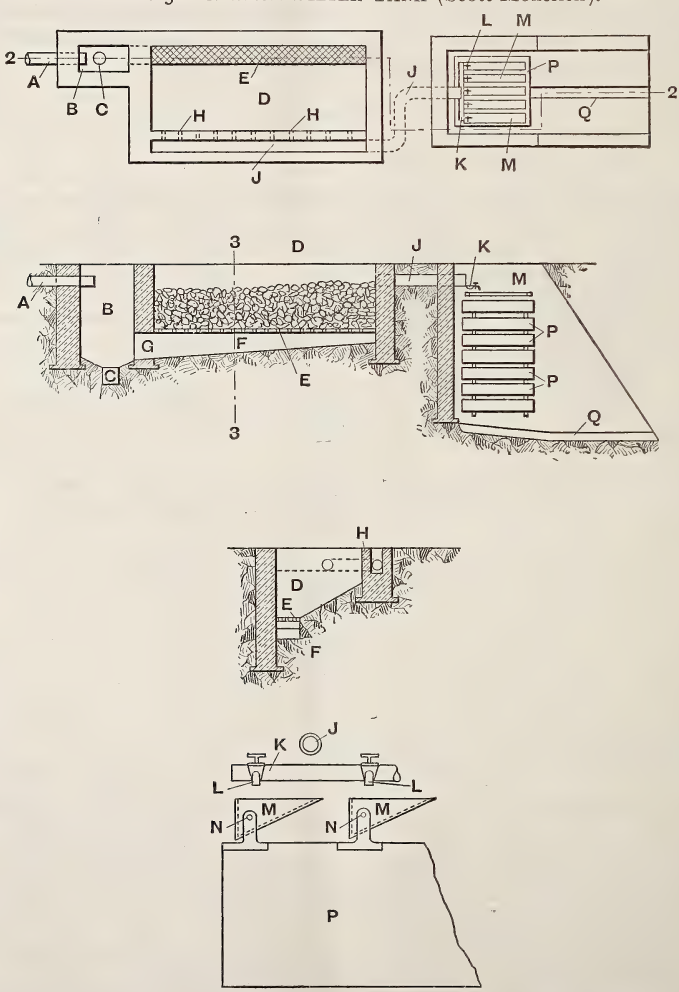
	Substances dealt with.	Characteristic products.
INITIAL. Transient aerobic changes by the oxygen of the water-supply, rapidly passing to :—	Urea, ammonia, and easily decomposable matters.	
FIRST STAGE. Anaerobic liquefaction and preparation by hydrolysis.	Albuminous matters. Cellulose and fibre. Fats.	Soluble nitrogenous compounds. Fatty acids. Phenol derivatives. Gases. Ammonia.
SECOND STAGE. Semi-anaerobic breaking down of the intermediate dissolved bodies.	Amido-compounds. Fatty acids. Dissolved residues. Phenolic bodies.	Ammonia. Nitrites. Gases.
THIRD STAGE. Complete aeration : nitrification.	Ammonia and carbonaceous residues.	CO_2, H_2O, and nitrate.

It has been already pointed out that in ordinary bacteria beds these reactions are somewhat fortuitously reversed and confused, according to the periods of filling or rest, the fault being caused by mixing all the different bacteria in one or two large filters.

By using a series of smaller, separate areas, and passing the effluent continuously and progressively through them, with ample opportunity for the access of the air where it is required, the organisms gradually choose their own conditions, and allied groups gather together at different levels as coatings on the filtering material. In the later sections the nitrifying organisms are almost alone, and are therefore able to exert their full activity. In this way Mr. Moncrieff has secured a much higher nitrification than has been attained by the other processes.

This he has accomplished by spreading the "tank effluent" by tipping troughs or distributors over the uppermost of a series of "nitrifying trays." (See Fig. 4.) The plant in use at Ashtead for a domestic

FIG. 5.—SEWAGE FILTER TANK (Scott-Moncrieff).



sewage consists of nine perforated trays containing coke, supported vertically over one another at about three inches apart. Each tray has an effective area of one square foot and contains seven inches of coke, broken to one inch diameter. It requires only from eight to ten minutes for the liquid to pass through all the trays. (Fig. 5.) In the early part of last year, after the apparatus had been running continuously for three months, I collected on two occasions samples from the different trays and examined them separately. The rate of flow was approximately measured as follows:—

	Flow observed. Per sq. foot.	Equal to gallons per acre per 24 hours.
Jan. 25, 1898.	1 litre in 15 minutes.	884,600
Feb. 8, 1898.	1,140 c.c. in 12 mins.	1,253,400
Mean ..		1,071,500

The results of analysis are given in the Table:—

PARTS PER 100,000.

	I.		II.		III.	
	0	9	0	9	0	9
Chlorine	9·0	7·5	6·3	6·4	5·5	5·5
Ammonia	11·5	0·25	4·25	0·755	4·0	0·42
Albuminoid ammonia	1·5	0·60	2·93	0·475	1·472	0·107
Nitric nitrogen	0·12	9·0	none	5·98	none	4·34
Nitrous nitrogen	none	slight trace	none	0·06	none	0·034
Total unoxised N	12·35	0·60	6·60	1·12	5·35	0·148
Organic N	2·05	0·394	3·10	0·50	2·06	0·113
Total nitrogen	12·47	2·60	6·60	7·16	5·35	4·522
Oxygen consumed	9·84	0·589	9·05	0·608	7·52	0·632

PER-CENTAGE PURIFICATION.

	I.	II.	III.	Average.
(1) Oxygen consumed	94	93·3	91·6	93
(2) Oxidation of nitrogen	93·7	84·3	96·7	91·6

The progress of the nitration is indicated in the annexed curve (Fig. 6, p. 726), on which I may offer the following remarks:—

1. The nitrate has developed with extraordinary rapidity. This may be seen from the following Table, which gives in the first column of each heading the original results and the chlorine; in the second, the results calculated to a uniform 10 parts of chlorine, to admit of comparison:—

TABLE OF COMPARATIVE NITRATION.—PARTS PER 100,000.

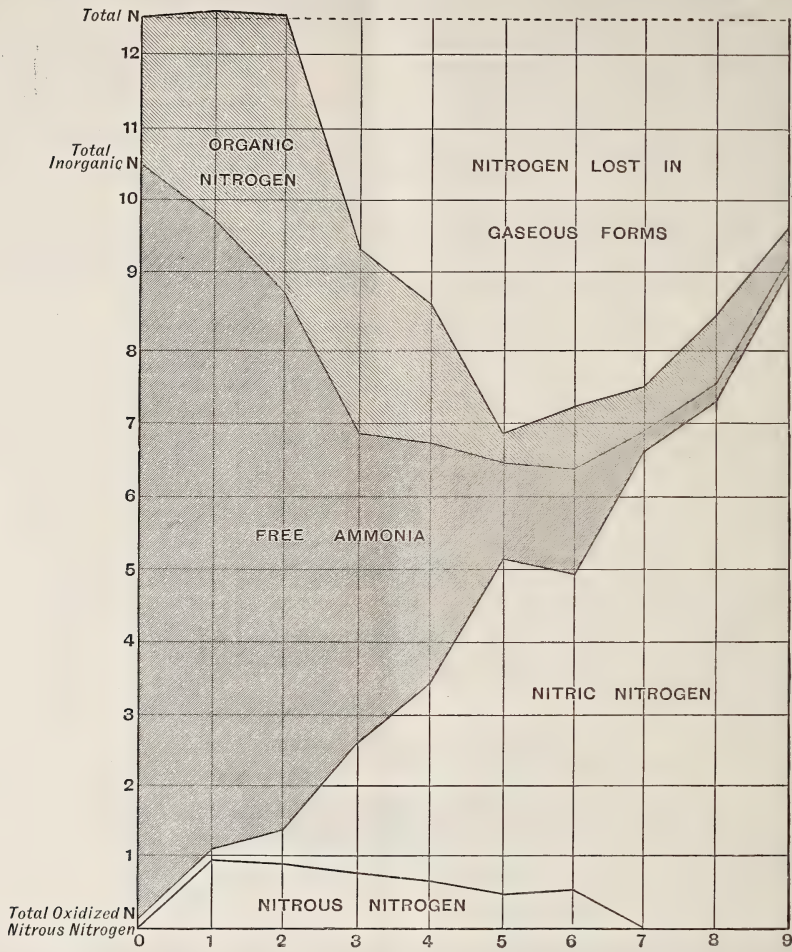
	Garfield: Manufacturing.		Garfield: Domestic.		Dibdin: Sutton.		Cameron: Exeter.		Scott-Moncrieff.					
									I.		II.		III.	
Chlorine	22·4	10	11·0	10	12·8	10	7	10	7·5	10	6·4	10	5·5	10
N as Nitrite					·067	·052	trace.	trace.	trace.	trace.	·06	·09	·034	·062
N as Nitrate					1·53	1·20	1·06	1·51	9·0	12·0	5·98	9·35	4·34	7·9
Oxidized N	1·67	0·75	0·95	0·86	2·20	1·25	1·06	1·51	9·0	12·0	6·04	9·44	4·37	7·96

2. The formation of nitrite is much less marked; it rapidly reaches a maximum and then declines.

3. The free ammonia has been almost completely oxidized; at the same time it was noticed that the original yellowish colour, black suspended matter and sewage odour had disappeared.*

* It is stated that "by transposing the trays so as to upset the natural survival of organisms in the sequence, the whole process was arrested, a high-coloured and inferior affluent being the immediate result, and one or two days were required to re-establish the conditions that had been disturbed."

FIG. 6.—NITRIFICATION IN BACTERIAL TRAYS (Scott-Moncrieff System).



The following figures give the oxygen relations which I found for the first and last trays:—

PARTS PER 100,000.

	Dissolved Oxygen. cc. per litre.	Oxygen consumed by organic matter.	Available oxygen.
Jan. 28th—			
Original	—	9·54	*minus* 9·57
Last tray......	—	0·39	*plus* 20·1
Feb. 8th—			
Original	0	9·05	*minus* 9·05
Last tray......	6·34	0·44	*plus* 12·99

The organic matter has been very greatly reduced for so brief a time of contact. The effluent is now in a state of rapid natural purification by means of its "available oxygen," a term I some time ago proposed for effluents rich in nitrates. We know by the researches of Warington, Munro, Adeney, Gayon and Dupetit, and others, that the oxygen of a nitrate is utilised for the burning up of organic matter, *provided the latter has been properly fermented*, as in this case it has. In my own experiments I have found that the large loss of nitrogen so often noticed was not accounted for by nitrous acid, ammonia, nor by nitrogen gas. Gayon and others have observed the production of nitrous oxide, which being soluble is not evolved and has no doubt been overlooked by many observers. Therefore, to be on the safe side, I have allowed four atoms of "useful oxygen" to every two molecules of nitric acid, according to the equation:—

$$2\,HNO_3 = H_2O + N_2O + 4O.$$

Deducting from this the "oxygen consumed" figure, as representing the organic matters which are fairly easy of destruction,

I call the surplus "available oxygen," ready to be drawn on to complete the purification. In the above case the quantity is obviously far greater than would be supplied by any process of mere aeration, hence, as I have previously stated,* "such an effluent could be easily 'finished' by a fine filter without fouling the latter, or could be beneficially applied to a small area of land, or mixed with a river of moderate volume not only without pollution, but possibly with an actual benefit to the stream."

The Noton Shelf Filter is described in the Manchester Rivers Committee report† as "a framework supporting four lattice shelves . . . on which the filtering medium, consisting of layers one foot deep of blue furnace cinders, is laid." It was attempted by this means to nitrify a chemically-precipitated effluent, but the report states that "but little purification is effected."

At Church, Messrs. Whittaker and Bryant allow the sewage to pass through open precipitating tanks, using 1 ton of lime per 1,000,000 gallons. The sludge so formed is either pressed or allowed to putrefy in the tank itself, which becomes covered with a leathery scum as in the closed septic tank. The effluent is distributed by a sprinkler on to the surface of the nitrifying filter, together with a small jet of steam, so that the filter is kept at a temperature to ensure the fullest activity of the bacteria. The filter is 9 feet deep, and is filled with coke broken to a 2½ inch ring, and works like the tank continuously, provision being made for a steady stream of air passing through the drains at the bottom up into the centre of the bed.

Major Bennett, the borough engineer of Southampton, has introduced at the Portswood Sewage Works a system including an anaerobic bacterial tank, followed by an aerobic or oxidation bed, which is reported to have been dealing "with a large volume of strong sewage for the past six months with remarkable results." It claims several advantages.

I will now give a brief summary of the changes through which the organic nitrogen of offensive matter passes on its way to the final inorganic products. The formation of transition substances and of ammonia we have already noticed, also the copious production of nitrogen gas, which in part is the direct secretion of certain bacteria, but more largely is the result of interactions, such as the following:—

Nitrosification, or the production of nitrites, and secondarily of nitrogen and its lower oxides, by *partial* oxidation, as it occurs in the second stage of bacterial purification. Wherever we find a final filter acting badly, either from deficient aeration, or other cause, the fault is at once indicated by the appearance of a high proportion of nitrites, as *nitrosification* is not nearly so delicate a process or so difficult to initiate or control as *nitrification*, or the production of nitrates, which it would naturally precede. Thus Winogradsky found widely distributed in soil an organism *nitrosomonas*, converting ammonia into nitrite, and another, *nitromonas*, later called *nitrobacter*, changing nitrite into nitrate. P. F. Richter isolated a coccus of medium size, which in 20 minutes produced a very intense nitrite reaction *in fresh urine*, and in addition reduced nitrate to nitrite, a retrograde change which I have already remarked as common to many bacteria, and characteristic of crude attempts to introduce nitrification before the sewage is properly hydrolysed and prepared. Some of my own experiments on this point are detailed in the "Journal of the Sanitary Institute," vol. xix., part iv., and have been already referred to. Nitrosification proceeds most rapidly in the presence of diffused light and of a moderate amount of air. It will be noticed that it is a characteristic stage reached in the earlier of Scott-Moncrieff's trays and in many processes the purification goes no farther, when nitrification is not subsequently active.

The amount of oxygen required for the processes of nitrification and nitrosification is shown in the following Table :—

One gramme of nitrogen requires :—

For production of	Grammes of oxygen.	Litres of oxygen.	Litres of air.	Litres of oxygen-saturated water at 7 cc. per litre.
N_2O_5	2·85	2·0	10·0	286
N_2O_3	1·7	1·2	6·0	170
N_2O_2	1·13	0·8	4·0	114
N_2O	0·57	0·4	2·0	57
N	..	..	..	..

So that to nitrify in an effluent, five parts of nitrogen per 100,000 (1 gramme in 20 litres) will demand about half its volume of air, or

* "Journ. San. Inst.," vol. xix., part iv.
† March, 1898.

about fifteen volumes of fully aerated water. This explains the comparative failure and frequent collapse of filter beds in large masses, especially if the fluid is a raw sewage or a merely screened or precipitated effluent without preliminary hydrolytic change, as with every 100,000 gallons of sewage, about 50,000 gallons of air must be continuously supplied.

Contrivances like fountains, cascades, and weirs can only raise the dissolved oxygen to the saturation point of about 7 cc. per litre, or 700 gallons per 100,000; although useful, if simple, like the aerator at Exeter, they are quite inadequate.

The nitrosification change is, however, very valuable in the second stage, as getting rid of the transition products, ammonia, amido-acids, and the amines by double decomposition into water, or hydroxy-compounds (which are afterwards broken up by fermentation) and nitrogen gas. As simple instances we have :—

$$NH_3 + HNO_2 = 2H_2O + N_2$$

$$\underset{\text{Amido-acetic acid.}}{(NH_2)\,CH_2\,COOH} + HNO_2 = \underset{\text{Glycolic acid.}}{(OH)\,CH_2\,COOH} + H_2O + N_2$$

$$\underset{\text{Ethylamine.}}{NH_2\,C_2H_5} + HNO_2 = \underset{\text{Alcohol.}}{C_2H_5OH} + H_2O + N_2$$

The change is therefore accompanied by a great loss of nitrogen, and a disappearance of odour. It takes place in the resting-full period of filters, and causes disappearance of more nitrogen than carbon.

Nitrification proper, or the production of nitrates, is due to one or more organisms capable of growing in culture solutions which are practically free from organic carbon. But, under natural circumstances, they act in succession to nitrous organisms, and in the presence of organic material, which they do not, however, by themselves decompose.* Some of the difficulties of the subject have been cleared up by Adeney's researches, who, by cultivation in known solutions, has eliminated disturbing factors. His conclusions are :—

1. In inorganic solutions, containing ammonia, nitrous organisms thrive, but nitric organisms gradually lose their vitality.
2. Nitrous organisms cannot oxidise nitrites to nitrates in inorganic solutions.
3. Nitric organisms thrive in inorganic solutions containing nitrites.
4. The presence of peaty or humous matter appears to preserve the vitality of nitric organisms during the fermentation of ammonia, and establishes conditions whereby it is possible for the nitric organisms to thrive simultaneously in the same solution as the nitrous organisms.

In an effluent which is properly prepared and well-aerated, nitrification can often be encouraged by seeding with a small quantity of a fertile garden soil.

The conditions of nitrification have been often stated but may be recapitulated.

* Winogradsky, Centr. Bakt., 1896, 2, ii. 415 and 449.

(*a*) In every case the formation of ammonia by some other organism precedes the appearance of nitrous or nitric acid.

(*b*) Some fixed base must be present to combine with the acid formed. Therefore in a sewage farm, if the soil is devoid of lime it must be added. Ordinary sewage contains fixed alkali derived from washing soda, and any acid discharges are generally neutralised by this and by the free ammonia. E. Chuard found that nitrification may occur in an acid medium, but that it was very slow.* Hence in strong manufacturing effluents a treatment with lime may be necessary before nitrification will take place.

(*c*) The solution must not be too strong, nor too alkaline. Warington found that a 12 per cent. solution of urine was the highest strength nitrifiable, and that the maximum alkalinity corresponded to 36·8 parts per 100,000 of N as ammonia carbonate, equal to 44·6 parts of ammonia. These are strengths which only under special circumstances would be approached in sewage. In the runnings from urinals, stables, &c., dilution would be necessary.

(*d*) Darkness and free admission of air.†

* *Comptes Rendus*, cxiv., 181.

† At this point I may incidentally draw attention to a curious fact. In nearly all published analyses, the chloride in the effluent is slightly lower than that in the corresponding sewage. Muntz pointed out that in nitrification, bromides and iodides were oxidised to bromates and iodates. Chili saltpetre (nitrate of soda), which has been produced by natural nitrification, almost invariably contains chlorates and perchlorates, sometimes amounting to 7 per cent. of the former and 5 per cent. of the latter; they are supposed to have been formed by bacteria. Dr. Tidy, some 20 years ago, found a loss of chloride in waters running over aerating wooden shelves, and suggested that it might be due to the formation of chlorates. (*Journ. Soc. Chem. Ind.*, Dec. 1898, p. 1160).

In natural soil, Warington proved that nitrification rapidly diminishes after 3 feet, and that there is no nitrification below 6 feet. Thudichum states that the maximum limit of depth for the best results from filter beds is 3 feet to 3½ feet. "Beds have worked well at 4 feet to 5 feet, but the alteration of a bed from 3½ feet to 5 feet was accompanied by some reduction in the quality of the effluent." And yet it is proposed to double the depth of the Barking filter from 3 feet to 6 feet.

Denitrification.—Two organisms were isolated from sewage by Gayon and Dupetit in 1886*, which, in the presence of organic matter, decomposed nitrates evolving nitrogen and nitrous oxide. They proved that the whole of the N was evolved, and that all the O of the nitrate united with the carbon of the organic matter to form CO_2, part of which united with the base to form acid carbonate.

Ampolla and Ulpiani, in 1898,† describe two bacteria which act similarly, giving, as they state, complete decomposition of the organic matter and nitrate to CO_2 and N, without intermediate production of nitrite. Sugars, fatty and amido-acids were equally broken up, thus:—

$$5\ C_6H_{12}O_6 + 24\ NaNO_3 = 24\ NaHCO_3 + 6\ CO_2 + 18\ H_2O + 12\ N_2.$$

Thus 5 of oxygen are utilised, instead of 4, as in the production of N_2O. This is an illustration of what I have said about "available oxygen," and the reason why an effluent that has been properly fermented and heavily nitrated is capable of rapid self-purification, and also of improving the condition of a river into which it may be discharged.

Adeney, in fact, introduced a process in which he added artificial nitrate of soda at the third stage to accomplish by this denitrification the final removal of any organic matter present, but as we have seen that the effluent is naturally nitrified by properly constructed filters, the expense of an artificial supply can be avoided.

This brings us to the question of *what is a satisfactory effluent*? In a paper at the last meeting of the British Association at Bristol,‡ I discussed the various standards that had been adopted at different times. The popular permanganate test for "oxygen consumed" is open to the objections that:—

1. So many modifications have been introduced in precedure that the figures obtained by different observers are seldom comparable, as instanced in the recent discussion at Manchester.
2. It mainly measures the carbonaceous matters which are not the most noxious.
3. It is incomplete even in measuring these, since many of them are very resistant to permanganate if used, as ordinarily, at low temperatures. For this reason I prefer to work at a higher temperature, namely, that of a water-bath at 80° *centigrade*, giving 2½ hours.
4. The influence of nitrites, which are abundant, as we have seen, in certain stages of purification, of high chlorides, and of iron and manganese salts derived from a chemical treatment, has not been satisfactorily eliminated, even by the adoption of time-limits, such as 3 minutes 15 minutes, 2½ or 4 hours.

Still more delusive is the *albuminoid ammonia*. Its absolute amount has little or no meaning, the main question being the *quality* of the matters yielding it, and the nature of the accompanying substances.

I have noticed that many dilute putrid sewages of offensive character have shown less albuminoid ammonia than the condemnatory limits of existing standards, and conversely, many effluents in a healthy state of self-cleansing have exceeded the arbitrary margin that is sometimes laid down.

Incubation tests, as adopted in the Manchester report, maintain the effluent for five days at 80° Fahr., and determine the oxygen absorbed in three minutes before and afterwards, also noticing any change of odour. The result is still arbitrary, as an effluent is not intended to be stored by itself, but when finished, to be discharged at once into water, which is moving and aerated.

In the above paper I also reviewed the standards of several local authorities, and pointed out that in these conventional limits no account was taken of the respective volumes of the effluent and the stream into which it discharged, nor of the local conditions and subsequent use of the stream for drinking purposes. Standards founded on the number of bacteria are also of little value, although only a low number of organisms of the Coli group should be permissible, with an absence of dangerous pathogenic forms.

In the first lecture I explained a formula for estimating the volume of a given effluent that

* Station Agronomique de Bordeaux.

† "Gaz. Chim. Ital.," xxviii. (1) 410; "Jour. Soc. Chem. Ind.," p. 1,160, Dec. 1898.

‡ "San. Record," Sept. 23, 1898.

TABLE OF THE RELATION OF NITROGEN TO CHLORINE, AND OF OXIDATION.

	Chlorine.	Total Nitrogen.	R. $\frac{N \times 100}{Cl.}$	Per-centage of Oxidation.
RAW SEWAGES :—				
Exeter	7·5	6·37	86	trace
Sutton	8·99	8·81	98	0·2
London	10·4	7·06	68	trace
EFFLUENTS AND FILTRATES :—				
London Outfall (removal of the N by precipitation)	10·5	4·26	41	trace
Exeter Septic Tank	7·5	5·96	80	0·3
Exeter Coke Breeze Filtrate	7·5	3·42	46	32
Sutton Bacterial Tank	6·94	2·97	43	19
Sutton Coke Breeze Filtrate	6·84	2·00	30	56
Ashtead Tank Effluent (1)	6·3	6·60	105	0
Ashtead Filtrate	6·4	7·16	112	84·3
Ashtead Tank Effluent (2)	5·5	5·35	97	0
Ashtead Filtrate	5·5	4·52	82	96·7

might be permitted to pass into any particular stream, founded on the ratios of oxidation.

I have on many previous occasions pointed out that a "calculation of the *ratio* between the different forms of nitrogen furnishes a clearer idea of the history and character of an effluent than a mere consideration of its amounts." Besides the formation of free ammonia in the transition or preparatory stage, and the conversion into nitrite and nitrate at a later period, we have seen that there is a considerable dispersion of organic nitrogen in the form of innocuous gases. I believe I am the first to propose an expression for the measurement of this important phase of the purification, obtaining the data from the

RATIO OF THE CHLORINE TO THE TOTAL NITROGEN.

In perfectly fresh excreta, taking the solids and liquids together, the total fixed nitrogen somewhat exceeds the chlorine. This proportion will remain practically unchanged when diluted with water containing only the ordinary small amount of chlorine, as long as the nitrogen remains in fixed forms. Therefore, the ratio is applicable to fresh sewages generally, independent of dilution, but will be immediately altered by the production of gas.

Let Cl and N be the parts of chlorine and nitrogen respectively, the "residual ratio" will be :—

$$R = \frac{N \times 100}{Cl}$$

or in case of great dilution, with a high chlorine W, in the water supply :—

$$R = \frac{N \times 100}{Cl - W}$$

The simpler formula is usually sufficient. In the original excreta the number R will be somewhat over 100; in fairly fresh sewages it will be about 100; in bacterial effluents, on the other hand, the fall of R will indicate the gaseous dispersal of nitrogen. With chemical or mechanical treatment R will fall owing to the abstraction of matter as sludge. Where heavy nitrification has been the main feature, there may be little or no fall, this afterwards occurring rapidly in the process of *denitrification*, when the effluent is admixed with other water.

CORRECTION.—Page 711, col. 1, *for* $\frac{130}{30}$ M, *read* $\frac{1 + 2 + 3 + \ldots\ldots 30}{30}$ M.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRACTICAL EXAMINATIONS IN MUSIC.

The practical examinations in Music were not concluded this year until the 12th July, too late for the results to be included in the Report of the Council. They lasted for 13 days.

The system of examination was the same as that for last year. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music, and for each standard a list of music is given for study, and for the pianoforte examination a selection from this list is sent to the candidates six weeks previous to the examination. For other instruments the pieces can be at once chosen from the general list. Candidates are then expected to play or sing the pieces which they have prepared, and in the third and fourth standards to play a piece, or a portion of a piece at sight, in addition.

In all 529 candidates were examined, a decrease of 9 as compared with last year; 3 of these took up two subjects, so that there were 532 examinations. Of these there were 508 passes and 24 failures.

The following were the subjects taken up:—Piano, singing, violin, viola, violoncello, mandolin, and organ. 419 entered for the piano, 399 of whom passed and 1 obtained a medal; 66 entered for the violin, of whom 56 passed and 5 obtained medals; 2 entered for the violoncello and passed; 1 passed for the mandolin; 5 entered and passed for the organ; 38 entered for singing, and all passed, 5 obtaining medals; 1 entered for the viola and passed.

Mr. John Farmer, of Balliol College, Oxford, and Director of the Harrow Music School, acted as Examiner, Mr. Ernest Walker, M.A., Mus. Doc. Oxon., and Mr. Burnham Horner, as Assistant-Examiners.

Miscellaneous.

THE HILL FORESTS OF WESTERN INDIA.*

It would be impossible, within the time prescribed for this paper, to attempt even a cursory description of the State forests in all parts of British India, or to render adequate justice to the work of the Indian Forest Department. I propose, therefore, to direct your special attention this evening to a limited area only in Western India, where the operations of the Department may be regarded as more or less typical of its general work. But, first, I should like to refer to some considerations which determine the applicability of a system of scientific forestry to any particular country, and to trace in outline the history of the measures adopted by the Government of India for the conservancy of forests in districts where scientific forestry is likely to secure permanent advantages to the people. I will also put before you some statistical information which may help to give an idea of the progress so far made.

It is obvious that in some parts of the globe it would be of no advantage at all to increase the existing forest areas, or to try to grow forests where no forests have ever yet grown. The increase of vegetation in some countries might indeed be a positive evil to the inhabitants. It might reduce the temperature of the air and of the soil where it is already cold enough for human comfort, as in places nearer to the Poles than we are; or it might increase the rainfall in sea-bound regions which are damp enough already; or it might unduly reduce the area of cultivation in thickly populated countries where people are mainly dependent on their own lands and crops for sustenance. Or, again, the afforestation of new lands might not be required for the production of fuel, or of materials for building ships or houses, or for railways or machinery, in countries already well supplied with peat or coal or iron, or other substitutes for firewood and timber. And, lastly, employment on forest industries might not be a matter of public concern in places where other industries sufficiently occupy the time and intelligence of the people.

But India is not a country where such considerations prevail. Dr. Schlich, Professor of Forestry at the Royal Indian Engineering College at Cooper's Hill, in his admirable "Manual of Forestry," prepared ten years ago at the instance of the Secretary of State for India, primarily for the use of the Forest Branch of the College, tells us that, as a rule, the nearer we are to the equator, the more important becomes the forest question. In a hot country, with distinct wet and dry seasons, forests may be necessary for the mitigation of extreme heat and dryness during a part of the year, and for the regulation of the flow

* A lecture, by H. M. Birdwood, C.S.I., LL.D., M.A. (late Member of Council, Bombay, and Vice President of the Bombay Natural History Society), given at the "Greater Britain" Exhibition, on the 4th July, 1899.

of water in springs and rivers. The climate of a continental country may be improved by forests, and a mountainous region is, according to the same authority, more in need of forests than a low-lying country, because forests tend to prevent landslips and avalanches, and the washing away of soil from hill sides, and the consequent silting-up of rivers; also they check the force and suddenness of destructive floods. In hilly countries, as elsewhere, forests provide protection from storms for men and beasts and birds.

Now India is distinctly a hot country, though in the northern provinces extreme cold is also felt in winter. It possesses, over a great part of its area, well-defined wet and dry seasons, dependent on constant causes recurring from year to year with the progress of the sun above and below the equator. Except on the sea coast, it possesses a continental climate, or, rather, several types of continental climate; and though there are vast plains within its boundaries, it is intersected by many mountain ranges, and even its plains and table-lands are broken by isolated hills and hilly tracts. It is clearly a land in which it would be suicidal to neglect the great question of forest conservancy. And yet it is only during the past fifty years that the vital importance of the question has been realised in British India. Early in the present century a timber agency was indeed established on the west coast; and in 1839-40, the Government of Bombay prohibited the cutting of teak trees on State lands. In 1843, Mr. Conolly, the collector of Malabar, made extensive plantations of teak at Nilambur, but no systematic plan for the maintenance of wooded lands for the supply of timber and other produce, or on account of their beneficial influence on the climate and public health, or for the protection of the soil or human dwellings from the violence of storms, and, in short, no plan for the regular administration of forests on well-ascertained principles was adopted till several years afterwards, when the danger of continued neglect could no longer be concealed.

There can be no question that, at one time, a very large part of the earth's surface was covered by forest growth, the destruction of which has affected the drainage of the soil and even its external configuration. Local climates have probably also been affected, though such causes as the drainage of marshes and the operations of husbandry are also believed to have contributed to such a result by altering the hygrometric, thermometric, electric, and chemical conditions of the atmosphere. As observed by Mr. George Marsh, in his suggestive treatise on "The Earth as Modified by Human Action," "it is but recently that, even in the most populous parts of Europe, public attention has been half-awakened to the necessity of restoring the disturbed harmonies of nature, whose well-balanced influences are so propitious to all her organic offspring, and of repaying to our great mother the debt which the prodigality and the thriftlessness of former generations have imposed on their successors." As regards India, the evidence disclosed by ancient writings seem to show that it was covered to a great extent, at one time, by forests. Dr. Schlich thinks that the country was more fertile then than it is now, and the climate less fierce; and he refers to the testimony of the great Chinese traveller, Fa-Hian, who described the climate as neither cold nor hot. Subsequently, as settlers began to occupy fertile valleys, forest lands along the banks of the great rivers were more and more cleared for cultivation. Such a proceeding was inevitable, and it would be idle to regard it as an interference with the order of nature, for, so long as it merely met the actual needs of human beings, it was really in aid of those harmonious methods by which, during countless centuries, the earth has been fitted for human habitation. But man must now take his part in the further development of those methods, if the great end in view is not to be defeated, and if successive generations of men are to pass on the inheritance they have enjoyed, not unimpaired merely, but improved to the best of their power. Such a conception of human duty was, however, unknown to the nomadic tribes, who, according to Dr. Schlich, for a period of more than 750 years, carried on the work of destruction, not only in fertile valleys, but alike on hills and plains, as they moved from one pasture ground to another. In his preface to the catalogue of the Indian exhibit at the International Forestry Exhibition held at Edinburgh in 1884, Sir George Birdwood says that it was the destruction of vegetation over wide extended areas at the time of the troubles following the decline of the Moghal Empire which thenceforward rendered India liable to desolating droughts and the consequent calamity of often recurring famines. "In the course of time," says Lieut. Col. F. Bailey, formerly Superintendent of Forest Surveys and Acting Inspector-General of Forests in India, and now Lecturer on Forestry in the University of Edinburgh, "not only were large areas entirely cleared for cultivation and for village sites, but more numerous flocks and herds, driven for their daily food into the jungles, led to the impoverishment of a forest belt of ever-increasing width around the occupied tracts." During the hot season, dry grass, fallen leaves, and dead wood were set on fire in order to clear the ground for a fresh growth of grass for cattle, and also to simplify the pursuit of game. But such practices, with those of overcutting and digging up roots for fuel, soon destroyed the protective forest growth, and heavy rains then washed away the soil. Cows and bullocks could no longer be kept in good condition on the scanty herbage that remained, and the villagers began to keep large flocks of goats, "against whose hoofs and teeth," as Lieut.-Col. Bailey remarks, "it is well known that forest growth cannot contend." The village goats are still formidable foes to young plantations, though, in the estimation of Sir Clements Markham, "the uneducated man," in his dealings with forests, goes far beyond the goat in his capacity for mischief.

It would be satisfactory to be able to say that a wiser policy prevailed after the establishment of British rule. But, unhappily, that was not the case for many years. "With the advent of British rule," says Dr. Schlich, "the destruction of the forests became more fierce than ever." The extension of cultivation "at the cost of the still existing forests" was carried out for many years "without any inquiry as to the ultimate effects." With the introduction of railways a further impetus was given to cultivation in the immediate neighbourhood of railway lines and stations; and, with the steady increase of prosperity under a settled Government, the demands for timber and firewood increased enormously throughout the country; and thus the reduction of forest areas went on with all its attendant evils. In illustration of the evils which attend and follow the reckless destruction of forests, especially in hilly regions, Lieut.-Col. Bailey cites the case of the outer Himalayan spurs in the Hoshiarpur district of the Panjab, where, as the rock is very friable, serious damage has been caused by denudation. Within the memory of living men, these hills were well covered with forests or tall grass, and the hill streams ran evenly in well-defined channels. But the natural vegetation has now almost entirely disappeared, the hills are crumbling away, and loose rocks and stones are carried down by the streams, which are often several hundreds of yards wide, and deposited in the plains below. "Thus, not only have the hills themselves become a dismal and profitless waste, but the fertility of extensive areas of cultivation near their base has been completely destroyed by the stony deposits laid on them."* Similar causes have produced similar effects in other parts of India. I can myself speak of some of the districts to the south of Bombay, between that great western ramp of the tableland of the Dekhan—the range of the Sahyádri Ghâts—and the sea; a narrow, hilly tract of land, known as the Konkan, and traversed by numerous streams having their sources in the Ghâts. Within living memory many of the hills were well wooded, and some of the streams were navigable by larger craft than any that can now make their way to the towns and villages on their banks. Here, as elsewhere, disastrous results have followed the destruction of forests. The mould which, in the shelter of the jungle, had been formed during centuries on the rocky surface of the hills—to which it had been bound by a living network of fibrous roots—became exposed to the full force of the monsoon rains. The average annual rainfall, near the sea, amounts to about 80 inches, and gradually increases till, about 30 miles inland, at the ridge of the Ghâts, which forms the watershed of the rivers flowing eastwards and westwards, it reaches an average of about 280 inches in the year. A wide view of these Konkan hills is obtained from the hill station of Mahableshwar, on the crest of the Western Ghâts, at a distance of about 80 miles in a south-easterly direction from Bombay, and I well remember a conversation I once had there with Mr. Allen Shuttleworth, who for many years held, with distinction, the office of Conservator of Forests, from which he has lately retired. Like other officers of his Department, he was full of zeal for his work, and spoke in indignant terms of the folly and the mischief of which the evidence lay before us in sun-baked summits and barren sides of hills which, not very long ago, were clothed with all the glory of tropical vegetation. It is not easy to appreciate all the mischief that has been done. The silting up of waterways alone means commercial loss to the whole country side. It also means agricultural and pastoral loss to those from whose possession the soil itself has slid away, past recovery. In many places in the Southern Konkan district good soil is only now found in depressions on the surface of the laterite rock of the district, from which it could not be washed away. The whole community must suffer also from the increased cost of fuel and timber.

It is easy, in the light of our present knowledge, to condemn the heedless policy of the past, but I doubt whether it is for us in England to cast the stone. Though England has done a great deal towards the education of scientific foresters, we have the testimony of Sir Joseph Fayrer that it makes one almost ashamed, when travelling almost anywhere on the Continent, to see how comparatively well the woods are cared for there, and how they are neglected here. "There were miles and miles," he is reported to have said, "especially in the north, where there were only little bits of cover here and there, thoroughly neglected and of no use at all, except, perhaps, as shelter. There was no knowledge and no care, trees were planted and left to grow, or be blown down by storms, and there was practically no re-planting."* Such a remark would not, I think, be applicable to any rural district of British India at the present day.

It was not, however, until the increasing difficulty of meeting demands for public works indicated unmistakeably the existence of a timber famine, that the Indian Government realised the gravity of the situation. According to Dr. Schlich, the remedial measures at first adopted were only "half-hearted." But when their insufficiency was made clear a special State Department was organised. The efforts which preceded that event were not, however, unimportant or without effect on subsequent arrangements. Indian botanists had long urged on the Government the necessity for establishing a regular system of forest administration and preventing, in the public interests, the continued destruction of public property of enormous value; and the dawning of a new era was marked by the appointment, in 1847, of the late Dr. Gibson, to be Conservator of Forests in the Bombay Presidency. The most important duty assigned to him was the maintenance of the supply of teak for ship-building to the Government dockyard in Bombay, and his work as a pioneer of practical forestry was of

* Lieut.-Col. Bailey on "Forestry in India." *The Scottish Geographical Magazine* for 1897, p. 576.

* *Journal of the Society of Arts*, vol. xliii., p. 107.

special value in Western India, where he was familiarly known as "Daddy Gibson" and is still remembered, with affection, by the people of the Junar district above the Ghâts, where he had his head-quarters. As early as in 1847 the well-known name of the late Dr. Hugh Cleghorn, who has been described as the father of scientific forestry in India, appears in a report on the proposed conservation of forests in Mysore. In the following year our Chairman, General Michael, who was then Lieut. Michael of the 39th Madras Infantry, and has been described by Sir Joseph Fayrer as the father and pioneer of practical forestry in India, was entrusted by the Government of Madras with the organisation of an establishment for working and conserving the public forests near Coimbatore and Cochin. He opened out forest roads and timber slips down the mountain passes and cleared belts of brushwood to preserve young saplings from fire. Indeed, in the Anamalai teak forests, he made "the first recorded attempt to protect Indian forests from injury by annual jungle fires."* Also by giving employment to the hill tribes he secured their co-operation in his plans. In the discussion on a paper on Forestry read by General Michael before the Society of Arts in December, 1894, Sir George Birdwood referred to certain attempts in the same direction made about the same time in Bombay and Tennaserim, which however met with no success, partly because they were on too ambitious a scale, and partly because the ancient forest rights of the people were not sufficiently considered. "General Michael," he said, "set to work in a more modest manner and in a far more conciliatory spirit and after six years his exertions, which completely broke down his health, were crowned with such success that the Court of Directors in London at once took up the subject warmly and rapidly extended the Madras system of conservancy all over India and as much of Farther India as was under their rule." I trust our Chairman will forgive my quoting these words in his presence. I have felt myself bound to quote them in justice to my subject and in deference to you who look to me for a full statement of facts. In the same discussion General Michael was referred to by Sir Joseph Fayrer as "certainly one of the great benefactors of India."

No account of Indian forestry, however summary, would be satisfactory without a reference to his services. It was the enthusiasm born of a love of woodland life, innate in such men as Dr. Gibson and himself, and the out-of-door experience acquired by them and others, whether as foresters or sportsmen, and interested as such in every phase of forest craft, which really prepared a firm foundation for the stately fabric of scientific forestry raised by their successors.

It was from the city of Edinburgh, with its grand botanic gardens, and its long array of men of science, prominent among them, in our own time, in connection with much that relates to the science of forestry, being Professors James Hutton Balfour and Bayley Balfour, that the effective impulse was received which determined the further development of the Forest Department. In 1850, the British Association met in Edinburgh and appointed a Committee to consider the probable effects, from an economic and physical point of view, of the destruction of tropical forests. In the following year the Committee presented at Ipswich a report which embodied the general conclusions and recommendations arrived at, and demonstrated clearly the importance of preserving every condition tending to maintain an equilibrium of temperature and humidity, of preventing the disappearance of indigenous forests from the wasteful habits of the people, and of taking the requisite steps for extending forest produce. The weighty evidence adduced by the Committee and the broad views enunciated by them so impressed the Court of Directors that, within a few years, regular establishments were sanctioned for the Madras Presidency and British Burmah. In 1856, Dr. Cleghorn took up General Michael's work, and was appointed Conservator of Forests in Madras, with Captain Douglas Hamilton and Lieutenant Beddome as his assistants, who in turn succeeded him in the office of Conservator after his transfer, first to Bengal, where he gave most efficient aid to Dr. Brandis in carrying out forest conservancy, and afterwards to the Panjab. According to Colonel Bailey, Dr. Cleghorn checked the destructive practice of temporary cultivation in the Madras forests, notwithstanding the opposition he encountered. He was utimately successful "because his well-known desire to promote native interests inspired the rulers of the country with confidence in his proposals." In 1856 also, Dr. Brandis (now Sir Dietrich Brandis, K.C.I.E.) was appointed superintendent of Forests in Pegu, and six years afterwards was placed on special duty with the Government of India. He was the first Inspector-General of Forests to the Government of India, and held the office till 1881, when he went on special duty to Madras. His book on the Forest Flora of North-Western and Central India is a standard work, greatly prized by Indian botanists and foresters. "From the time of his appointment," says Sir George Birdwood, in his preface to the catalogue of the Indian exhibit at the International Forestry Exhibition, already referred to, "the successful future of forest conservancy in India was assured. . . . . He, in fact, by his great capacity, his wise recommendations, and his personal example of enthusiastic devotion to duty, has made the Forest Department of India what it now is." We owe to Dr. Brandis, among other important services, the suggestions for the various Indian Forest Acts, which, while strengthening the hands of the Government, have secured to the people the maintenance of all the ancient rights and privileges inherited by them from time immemorial; and also the inauguration, in 1866, of arrangements for the annual supply of trained officers to discharge the duties of assistant conservators of forests in India. At first, these officers were

* Lt.-Col. Bayley on "Forestry in India," *The Scottish Geographical Magazine*, for 1897, p. 576.

educated in France and Germany. In 1876 the student candidates were withdrawn from Germany and stationed at Nancy, under an English officer. In 1885 Dr. Schlich (who had succeeded Dr. Brandis on his retirement) organised the Forest Branch of the Royal Indian Engineering College on its present footing at Cooper's Hill.

While candidates with special qualifications for the higher grades of the Forest Department are, with some exceptions, now recruited from England, it is obvious that there must be much important work connected with the executive charge of the forest ranges, into which the larger divisions are split up, the disposal of which the Government of India must entrust to officers trained in India itself. The class of Forest Rangers has been described as the "backbone" of the Department. Candidates for this branch of the forest service are trained at the Imperial Forest School at Dehra Dun, which is attended by students from all parts of India. A certain number of forest appointments has also been guaranteed annually by the Government to the students of the College of Science at Poona. A protective service of Forest Guards is also employed for the purpose of patrolling forests and ensuring compliance with forest regulations. The members of this branch of the service receive no professional training.

The Indian Forest Service, thus organised, has been able not only to meet the demands of India, but to help other countries also. Ceylon, New South Wales, New Zealand, the Cape, Mauritius, Jamaica. and Cyprus, as General Michael, in his paper on Forestry, tells us with just pride, have all borrowed officers from India to put them in the way of organising conservancy and working their forests economically. The head of the Forest Department at the Cape and the Conservator in Ceylon are both Indian forest officers. The United States of America have also recognised the value of the work done in India by lately deputing an expert to study the methods there in force.

The forests to which the Indian Forest Act of 1878 is applicable include "reserved forests," which are State property, or over which the State has certain rights; "village forests," assigned or yet to be assigned by the Government to village communities from reserved forest areas; "protected forests," which, as regards the proprietary rights of the State, are on the same footing as reserved forests, but are subject to less stringent supervision—only certain kinds of timber being protected and all private rights of cultivation, pasturage and wood-cutting within the protected area being respected; and, lastly, "private forests," which are controlled only to such an extent as is necessary for their regulation or protection for certain special purposes. The Forest Department has also the control of State plantations of timber trees.

The area of British India, exclusive of the Native States, is about 960,000 square miles; and of this area more than 79,000 square miles had been constituted as reserved forests before the end of the year 1896-97. About 9,000 square miles were "protected," and nearly 26,000 square miles were tabulated as "unclassed." The total area under the control of the Forest Department amounted, therefore, to about 114,000 square miles, inclusive of about 1,100 square miles leased from Native States. Of this area, which is only about 7,000 square miles less than that of the British Isles, about 32,000 square miles are closed to all animals, and about 41,000 to browsing animals only. I am unable to give any exact statistics as to village forests and private forests, but it has been estimated that the area of private forests and forests belonging to corporations and endowments is about equal to that of the State forests, and that the total area of forests of all kinds is about 25 per cent. of the total area of British India. In Great Britain and Ireland the corresponding per-centage is only 4. The corresponding figures for Europe and the United States of North America are 31 and 17 respectively. In European countries the highest per-centage is reached in Servia, where it is 48; in Russia and Sweden it is 42; in Austria, 33; in Hungary, 29; in Germany, 26; in Norway, 25; and in Turkey (including Bulgaria, Bosnia, and Herzegovina), and also in Roumania, and Italy, 22. In Switzerland, Spain, France, Greece, and Belgium, it lies between 19 and 15. In Holland it falls to 7, in Denmark to 6, and in Portugal to 5. Great Britain and Ireland thus show the lowest per-centage of all the countries named, while India comes seventh in the list, being bracketed with Norway.*

The area of plantations directly under the Government of India and the Government of Madras is said to extend to 41,000 acres. In the Bombay Presidency the afforestation of waste tracts has been pushed with vigour, but I am unable to give the acreage. One of the plans adopted by Mr. Shuttleworth, in the central division,—as he has personally explained to me on the site of some of his operations on the hills near Poona,—has been to sow the seeds of all kinds of forest trees and shrubs broadcast on the ground. The results of the annual sowings have been satisfactory except in seasons when the rainfall has failed at the close of the monsoon. Hill tops and stony valleys which, 20 years ago, were bare and unsightly, are now well covered with innumerable saplings and most refreshing verdure. Similar results have been obtained on many of the rocky hills of the Dekhan.

The review of Forest Administration in British India for the year 1896-97, by Mr. B. Ribbentrop, C.I.E., Inspector-General of Forests, shows that, in that year, which is the latest for which I have any report, the State forests yielded more than 47,000,000 cubic feet of timber, nearly 100,000,000 cubic feet of firewood, nearly 135,000,000 bamboos, and minor produce to the value of nearly 3,250,000 rupees.

In the same year the exports from British India to foreign ports included 64,221 tons of teak wood,

* Schlich's "Manual of Forestry," vol. i., p. 54.

valued at nearly 7,000,000 rupees; sandalwood, ebony, and other ornamental woods, worth nearly 600,000 rupees; and such minor produce as caoutchouc, lac, lac-dye, cutch and gambier, myrobalams and cardamoms, worth abont 21,000,000 rupees.

The total value of exports, which reached nearly 28,500,000 rupees, was less by 6,500,000 rupees than the total value for the preceding year, the decrease being due almost entirely to the disastrous effects of plague and famine.

The gross revenue realised from forests during the year 1896-97 amounted to nearly 18,000,000 rupees, the surplus over expenditure having been 8,000,000 rupees. More than 17 per cent. of the gross revenue represented the estimated value of forest produce given away free or at reduced rates to right-holders and free grantees. When it is remembered that, before 1848, the forest revenue, which was treated as a branch of the land revenue, was very trifling, the progress made in the past 50 years is very remarkable. But, as most truly observed by Sir George Birdwood, in the paper from which I have already quoted, "the annual revenue which forest conservancy has as yet provided is utterly insignificant when compared with the capital value of the Indian forests redeemed by the British Government from certain destruction."

It would indeed be strange if such results had been achieved without opposition. I have already spoken of the conciliatory course adopted with obvious advantage by some forest administrators towards those whose privileges were affected by the stringency of the new regulations. Villagers on the outskirts of forests had for generations cut firewood and grazed cattle therein and cleared patches for cultivation without hindrance. The policy aimed at has been to stop the exercise of privileges incompatible with the continued existence of forests and to allow others as far as possible. But the necessity for a restrictive policy at all, while necessarily distasteful to rightholders, was not readily accepted as right by the local officers of the Indian Civil Administration, with whom it has always been an honourable tradition to seek above all things the happiness and contentment of the people. They were unable to look with favour on measures which seemed to indicate an excess of zeal on behalf of the State and to be in needless derogation of privileges long enjoyed without much apparent injury to public interests. It has been suggested that, though the accumulated mischief, caused by neglect of conservancy during a long series of years, is incalculable, yet it is not possible always to detect any appreciable damage done in a particular locality during a short period. Such a consideration alone might partly explain the tendency to reject as idle the fears of experts and to resent measures savouring of harshness and productive of discontent. In course of time, as forest management became stiffened and matured, friction was undoubtedly developed and gave rise to difficulties. One of the purposes of the Forest Act of 1890 was to give effect to recommendations for reconciling legitimate local demands with State requirements which were made by the Bombay Government on a consideration of the Report of a Forest Commission appointed with the object, as publicly declared by Lord Reay, of substituting "co-operation for antagonism, confidence for distrust, contentment for disturbance." The Bombay Government has recognised the principle that the central authority in forest matters, so far as the interests of the people are concerned, shall be the Commissioner of the Civil Administrative Division, and that the Forest Department cannot be regarded as the rival of the Revenue Department in respect of such matters. You will not expect me to give any details in illustration of the practical working of this principle. The result has been to bring the Forest Administration into closer union with the general Civil Administration of the country, to remove many causes of complaint, and to place forest work altogether on a sounder footing.

The particular area of which I spoke at the beginning of this paper is within easy reach of the City of Bombay. It includes hilly tracts of country on either side of the range of Western Ghâts, in the Dekhan and Konkan respectively, between the latitudes, roughly speaking, of Bombay and Satara. As compared with other forest areas elsewhere in the Presidency, it is by no means remarkable, so far as the production of valuable timber is concerned; but it is of interest as illustrating generally the methods of the Forest Department; and it is of special interest to the inhabitants of Bombay and many other cities in the plains, as it includes the two popular hill stations of Matheran and Mahableshwar, which owe much of their value as health resorts to their pleasant woods and abounding undergrowth of beautiful shrubs and flowering plants and ferns, which everywhere keep the ground cool, and the air sweet and fresh. Both in climate and splendour of wild woodland scenery they furnish an instructive contrast with those hills of the same tract which have suffered from the destruction of forests in the manner I have already described. An account of the forest flora of Matheran and Mahableshwar will apply generally to similarly preserved portions of the Western Ghâts and the adjoining regions; and, in the time that is left us, it will be sufficient perhaps if I deal only with the flora of these two hills. Their vegetation is not indeed identical. Dr. Theodore Cooke, formerly principal of the College of Science at Poona and an accomplished botanist, who always found his "pleasure in the pathless woods" whenever he could escape from college lectures, has estimated that, exclusive of grasses, about 140 flowering plants are found at Matheran which have not been seen at Mahableshwar, and 130 at Mahableshwar which have not been seen at Matheran. Some of the conditions which regulate the distribution of plants are not indeed equally operative at both places. Mahableshwar is about 70 miles nearer the equator than Matheran. The latter is an isolated hill rising from the plain of the Konkan, midway between the Ghâts

and the sea; whereas Mahableshwar is further from the sea, and is, to all intents, a part of the range of Ghâts. The highest point of Matheran is about 2,500 feel above the sea-level; whereas the Mahableshwar plateau is at a general elevation of 4,500 feet above the sea and rises at one point to 4,700 feet. These differing conditions are not without their effect. Some plants are found at Mahableshwar which will not thrive on the lower mountain top. Some Matheran plants, on the other hand, find the higher levels of Mahableshwar beyond their range. I will give a few instances. The most casual observer is struck by the wonderful undergrowth of brake-fern at Mahableshwar and of the arrow-root plant—which in October and November blooms on almost every square yard of the jungle—and by the beautiful profusion of the *Osmunda* fern, mixed with clustering roses and willows, along the upper stream of the Yenna river. At Matheran the brake-fern is scarcely known. In a few years it will be extinct, if it is not already so; for being rare it has been the prey of thoughtless fern-hunters and cannot defy their onslaughts. It would be impossible for any number of fern-hunters to destroy it at Mahableshwar, and so it is left alone. Even if unmolested at Matheran, it drags on at best but a feeble existence. The site is too low for it, the lowest limit of its range in the latitude of Bombay being apparently a little more than 2,000 feet above the sea-level. The Osmunda, again, is not known at Matheran, nor is the Willow (*Salix tetrasperma*), nor the Arrowroot (*Hitchenia caulina*), though other allied plants of the order *Scitamineæ* are plentiful enough. On the other hand, there are some well-known Matheran trees, such as the Kumbha (*Careya arborea*), the Malia or Indian ebony (*Diospyros assimilis*), and the Chandára (*Macaranga Roxburghii*), which do not grow on the Mahableshwar plateau at all. But after full account is taken of all divergences, it is found that many plants are common to the two hills. Such a coincidence is favoured by the practical identity of their geological formation, and by the circumstance that there is no great difference in the range of their mean temperature at different seasons and in their rainfall. Both Mahableshwar and Matheran are huge masses of trap, capped by a thin layer of laterite. Both are within sight of the sea. Both are swept by the same dry winds in the cold weather, and by the same monsoon storms, and both enjoy the full benefit of the monsoon rains. The average mean temperature ranges at Mahableshwar from 63·3° Fahr. to 71·7°, and from 67·8° to 73·5° at Matheran. The average annual rainfall at Mahableshwar amounts to 281·4 inches, and at Matheran to 224·7 inches. Under such concordant influences, it is not surprising that a marked similarity should be apparent in the general outward forms of vegetation on the two hills, due to the frequent presence of the same characteristic plants on both. Everywhere at Mahableshwar, as at Matheran, we find the Myrtle tribe represented by endless woods of the beautiful Jambul tree (*Eugenia Jambulana*), the Melastomas by the Anjan or Ironwood (*Memecylon edule*), the Laurels by the Pisa (*Litsæa Stocksii*), and the Madder tribe by the thorny Gela (*Randia dumetorum*), a small tree, generally a shrub, with numerous stiff branches, armed with spines, and large fragrant white flowers, which turn yellow before they fade. There is the same undergrowth of shrubs and herbaceous plants, the natural orders of *Leguminosæ*, *Acanthaceæ*, and *Compositæ*, being specially and numerously represented. There are many showy climbers, trailers, and creepers, and Orchids and Dendrobiums common to both hills; while everywhere the little silver fern covers with equal impartiality every sheltered bank and rock. Some years ago, before leaving India, I prepared for the "Bombay Natural History Society's Journal, with the aid of several competent botanists, a catalogue of the flora of Matheran and Mahableshwar. I cannot pretend that it is a complete list, for the simple reason that during the four rainy months of the year, when most herbaceous plants are at their best, the hills are practically inaccessible to Europeans; but in addition to the hill flora it includes some of the more conspicuous plants on the higher levels of the road from Poona to Mahableshwar; and the list of forest trees, which are conspicuous at all times, may perhaps be accepted as complete. It may interest you to know that of the 733 names included in the catalogue, about 125 are the names of trees or sub-trees, as distinguished from shrubs, creepers, grasses, ferns, and undergrowth generally. Of the trees probably not more than ten species have been introduced, and about 115 species are probably indigenous. They constitute but a small proportion of the indigenous trees found throughout India, the number of which exceeds 2,000 species, but they give some idea of the diversity of forest vegetation in the limited area under consideration, if we bear in mind that the number of species of indigenous trees in Great Britain is only forty.*

The trees which have been distinctly introduced are the Peach, which is cultivated at the hill station of Panchgani, near Mahableshwar; the Stringy Bark (*Eucalyptus obliqua*), which does not take kindly to Mahableshwar, the rainfall there being evidently too heavy for it, but does better at Panchgani,—which, at a distance of only ten miles from Mahableshwar, has a much lower rainfall—though not nearly so well as on the Nilgiri Hills; the *Cinchona succirubra*, which again has not been a success, as on the Nilgiri Hills and elsewhere; the Cassowary tree, or Beefwood (*Casuarina equisetifolia*), which has been extensively planted at Panchgani, but much prefers the lower lands nearer the sea, and especially the sandy beaches of the Konkan coast; the Oak (*Quercus robur*), of which, however, there are very few well grown trees; and the Mulberry (*Morus alba*), which was probably brought from China.

Among the more important or more conspicuous

* Lieut.-Col. Bailey on "Forestry in India." *The Scottish Geographical Magazine* for 1897, p. 572.

trees which may be regarded as indigenous are two species of Garcinia—the wild Mangosteen (*Garcinia indica*) and the Gamboje tree (*Garcinia ovalifolia*); and two species of Sterculia—the *Sterculia urens*, from the wood of which native guitars are made, and the Goldar (*Sterculia guttata*), conspicuous by its large, peach-shaped fruit, covered with scarlet down; the Silk-cotton tree (*Bombax malabaricum*), which attains a great size, and is a tree of strange beauty when in full bloom, with its large, showy, rose-red flowers; the Kásu (*Elæocarpus oblongus*), with leaves turning red in autumn, and clusters of flowers with white-fringed petals and reddish-brown sepals; the Frankincense tree (*Boswellia serrata*), which is plentiful on the Ghât road between Poona and Mahableshwar; and another balsamiferous tree, the *Canarium strictum*, yielding a gum, burnt as incense by the hill people at their religious services, and much sought after on account of the rarity of the tree, of which I have found only one specimen at Matheran, to my lasting wonder at its presence there, in a thick wood, far from its congeners, and hemmed in by countless aliens; the *Garuga pinnata* (belonging also to the same natural order *Burseraceæ*), the bark of which is used in tanning; the Indian Satin-wood (*Chloroxylon Swietenii*), an excellent wood for cabinet work of the better kind; the Indian Red-wood or Bastard Cedar (*Soymida febrifuga*), the bitter bark of which is used as a substitute for cinchona bark; two species of the Jujube tree (*Zizyphus*); the Koshimb tree (*Schleichera trijuga*), on the young branches of which lac is produced in many parts of India; the well-known Mango tree (*Mangifera indica*), which is found wild on many hills, though sometimes said to have been introduced by the Portuguese monks from Brazil; the "Flame of the Forest" (*Butea frondosa*), which has given its name,—Palas" in the vernacular,—to the memorable plain of Palási, commonly known as Plassey; the Blackwood tree (*Dalbergia latifolia*), of which is made the elaborately-carved furniture, which at one time was much prized in Bombay; the beautiful Indian laburnum (*Cassia fistula*; the *Acacia Suma*, from the wood of which Catechu is manufactured; and yet another beautiful representative of the order *Leguminosæ*, the Laeli (*Albizzia stipulata*), a very conspicuous tree at Matheran, with clean stem and spreading branches, finely pinnate leaves, and large acacia-like flowers, with numerous, white, lilac-tipped stamens; the Ain (*Terminalia tomentosa*), a valuable timber tree; the Myrobolam tree (*Terminalia Chebula*), which is found in great abundance on Mahableshwar, the fruit—the Chebulic Myrobolam of commerce—being largely exported, coming indeed, for the whole of India, third on the list of exports of forest produce, as regards valuation, and second, as regards quantity; the Jambul tree (*Eugenia Jambolona*), already referred to, which may be regarded as the most characteristic tree of both Matheran and Mahableshwar, impressing as it does, most effectually, its grace of form and beauty of colour on all the landscape and shading the ground everywhere with a cool canopy of sweet-scented leaves; another tree, also of the Myrtle order (*Careya arborea*), which has been already referred to; the Ironwood (*Memecylon edule*), which has also been referred to and is also a characteristic tree of both hills, with its dark shining leaves, like the leaves of the Camellia; the Benteak tree (*Lagerstroemia parviflora*), which yields a wood of excellent grain for the cabinet-maker; the Kánta Kumbal (*Sideroxylon tomentosum*), a tough, hard-grained tree, as its name implies; the *Bassia latifolia* or Mowrah tree, from which Mowrah liquor is made in other parts of India; and yet a third tree of the Sapodilla order, the Bokul (*Mimusops Elengi*), with dark green foliage and honey-scented flowers; the *Diospyros assimilis*, one of the Indian ebonies; the Kaola (*Symplocos Beddomei*), with blossoms scented like the hawthorn and blue berries; the wild Olive (*Olea dioica*); the Wáras (*Heterophragma Roxburghii*), a tall tree of the Bignonia or Trumpet-Flower Order, with grey pinnate leaves and clusters of showy white bell-shaped flowers; the Teak tree (*Tectona grandis*), the most important of all the forest trees; the Shewan (*Gmelina arborea*), the pale yellow, close-grained wood of which is used for planking, furniture, the panels of doors, &c.; the wild Nutmeg (*Myristica attenuata*); and 15 species of the Laurel order, all notable and some of them very beautiful trees, the two most notable being the *Litsæa Stocksii*, already referred to, a shapely laurel rising to a height of 20 feet or more, and generally assuming a pyramidal tapering form, and displaying whorls of pale bluish leaves—a very characteristic tree of both hills—and a species of Cinnamon (*Cinnamonum Tamala*), of which I have found only four specimens, all at Matheran, a striking and handsome tree, though of no great size, with tufts, when first bursting into leaf, of small, pink, transparent leaves, which afterwards lengthen and become pointed at both ends, and have marked ribs or nerves, and are dark and shining above, and when dried turn to a rich brown, and yield a spicy scent when crushed. These, with several species of trees of the Spurgewort order (*Euphorbiaceæ*), which is well represented on both hills, and includes the *Macaranga Roxburghii*, already referred to, and readily recognised by its large ovate and peltate leaves, and the Hasána (*Bridelia retusa*), a good timber tree; and of the genus Ficus, which includes the well-known Banyan tree, the sacred Pipal, the Sycamore tree of the Bible, and other Figs, not so well known; the stately and fine foliaged Jack tree (*Artocarpus integrifolia*), with its enormous fruit, allied to the Figs, the Willow (*Salix tetrasperma*), and the Fish tail palm (*Caryota urens*)—the only palm included in my catalogue—make up a fairly full list of the more conspicuous of the forest trees on the two hills.

I wish I could convey to you something more than a dim conception of the beauty and perennial charm of these Indian woods. But that is beyond my power. It will be enough for me, and I shall be

quite satisfied, if, by my narrative, imperfect and meagre though it be, I shall have helped you in any degree to appreciate the value of the great work done by those who have preserved and improved the forest tracts of British India to the lasting benefit of the State and the people.

Some lantern slides will now be shown, illustrative of forest scenery and particular forest trees. I would also direct your attention to some specimens of forest wood on the table, which have been selected and polished by Messrs. John Roberts and Company, of Bombay, being woods in common use for cabinet work.

In proposing a vote of thanks to the lecturer for his highly interesting and instructive paper, the CHAIRMAN (General Michael) said that, as Mr. Birdwood had paid him the compliment of alluding to him, personally, in connection with the early efforts of the Madras Government to introduce a workable system of forest conservancy into India, he might perhaps add a few words to what Mr. Birdwood had said. There are few men, he said, now left alive among the Indian services who knew or could remember—as he did—what the state of affairs was, as regards forests, half a century ago, when the Madras Government made the effort spoken of. In those days hnndreds of acre s of primeval forests used to be ruthlessly cut down and burned by the inhabitants, for the sake of a few scanty crops of millet. Timber merchants used to be allowed to go into richly wooded tracts and work their wicked will. No thought seemed to be taken of the hereafter. But in 1848 an experimental establishment was organised for the protection and the economical working of one of the most valuable tracts of forest in the far south of the Madras Presidency. Mr. Birdwood had stated that, after seven years of somewhat uphill work, a pronounced success, both financial and preservative, was achieved, and the ball was thus set rolling. Success was the one thing needed to cause the Court of Directors of the East India Company to take the matter up warmly—conservancy measures and establishments spread rapidly all through India—and with what result? In 1848 the forests of India were fast being ruined by neglect and reckless waste, and the revenue was practically *nil*. By 1898 all existing forests were not only saved and put under good care, but he (the Chairman) was afraid to say how many thousands of acres or square miles had been planted or reafforested, and the net annual revenue stood at £1,000,000 sterling, or more. By that time also most of our colonies and dependencies, and even the United States, had taken a leaf out of India's book, and had established forest conservancy departments. Of course, this gigantic success is due to the measure having reached Imperial proportions. Madras can only take credit for a share of it, but she is justly entitled to look back with satisfaction to her pioneering scheme having been started on a sound basis, and to its having thus proved a success. Too much stress cannot be laid on the value of two principles on which the work was begun—firstly, that full and liberal recognition and respect for the ancient communal rights of the people should always be maintained, and secondly, that, in carrying out forest conservancy, preservation of the natural resources should be the first consideration, and the acquisition of revenue a secondary one. The ancient rights of the people over forest land is a matter with which it is vitally necessary to deal in a liberal spirit. The early records of the Indian Office show that on this rock both Bombay and Tenasserim split when conservancy was first attempted there. This same rock has frequently cropped up since—as all forest officers know well—and a most dangerous one it is—because if once the local people think they have been badly or illiberally treated they have a thousand and one methods of showing hostility to the Department, and, maybe, to the Government itself. It was highly satisfactory to see that Lord Roberts, in the political part of his autobiography, took a clear-sighted view of this very question, and sounded a note of warning against undue over-riding of ancient forest rights, as a probable fertile source of discontent in India. He thanked Mr. Birdwood warmly on behalf of the meeting.

ROYAL MINT REPORT.

The twenty-ninth annual report of the Deputy-Master and Comptroller of the Mint for 1898 has lately been published, from which it appears that the number of pieces struck in the Operative Department on account of Imperial and Colonial coinages during the year amounted to 98,099,217, exceeding the largest number struck in any preeeding calendar year by 2,261,402 pieces.

The real and nominal value of the Imperial coinages issued during the year, as compared with the year 1897, and with the mean of the ten years 1888-97, was as follows:—

	1898.	1897.	Mean of ten years, 1888-97.
Gold	£5,780,446	£1,178,437	£6,318,754
Silver	£1,312,306	£982,001	£1,188,885
Bronze	£84,555	£107,230	£69,790
Totals...	£7,177,307	£2,867,668	£7,557,428

The sterling issue in 1898 is thus considerably above that of last year in value, although about £400,000 less than the average of the preceding ten years, owing to the large re-coinages which have recently taken place in gold, the silver and bronze issues being also above the average. The demand for Colonial subsidiary coin was again very large, having risen from 35,154,000 pieces in 1897, to 39,896,607 pieces last year.

In the early part of the year 1898 the question of making good the deficiency of weight on the light gold coin sent in by the Bank of England since March, 1892, under the provisions of the Coinage

Act of 1891, had to be dealt with. Up to the 30th of September, 1897, that deficiency amounted to 134,294·800 ozs., representing at the Mint value a sum of £522,910 7s. 7d. As the market price of gold was at that time considerably below the Mint price, it appeared the best course to purchase the weight of gold required in the open market, and to convert it into coin. Messrs. N. M. Rothschild and Sons undertook to procure the gold required within a short period of time, and the whole weight was accordingly delivered into the Mint at a cost of £522,630 11s. 11d., an average price of 77s. 10d. per ounce, including brokerage. The first delivery took place on the 17th of February, and by the end of the month the larger part of the purchase (£417,698) was completed — the balance was delivered at intervals between the 1st and 14th of March. The gain to the Coinage Fund was £279 15s. 8d. on the transaction.

The nominal value of the worn silver coin withdrawn from circulation in the United Kingdom during 1898 amounted to £346,096 13s., making, with that withdrawn from the Colonies, a total nominal value of £377,456 10s. 4d. The total weight of the silver coin withdrawn was 1,229,795·23 ozs., showing a loss of £39,262 16s. 7d., equal to 10·4 per cent. on the nominal value.

The following are the particulars regarding the several denominations of sterling silver coins issued during 1898, exclusive of Maundy money :—

Denominations.	United Kingdom.		Colonies, &c.		Total.	
	Value.	Number.	Value.	Number.	Value.	Number.
	£		£		£	
Crowns	45,850	183,400	800	3,300	46,650	186,600
Half-crowns	166,650	1,333,200	77,700	621,600	244,350	1,954,800
Florins	133,150	1,331,500	181,770	1,817,700	314,920	3,149,200
Shillings	226,300	4,526,000	268,700	5,374,000	495,000	9,900,000
Sixpences	114,150	4,566,000	35,260	1,410,400	149,410	5,976,400
Threepences	30,600	2,448,000	30,980	2,478,400	61,580	4,926,400

The nominal value of the bronze coins issued during the year was £84,555, a reduction as compared with the preceding year, when the value amounted to £107,230. More than half the issue took place in the last three months of the year, when the demand for new coin is always active, the issue for the first nine months of the year having amounted to £41,295, and in the last three months to £13,260. The following are the particulars of coins issued :—

	Number of pieces.		Value.
Pence	14,961,600	..	£62,340
Halfpence	8,738,400	..	£18,205
Farthings	3,849,600	..	£4,010
	27,549,600	..	£84,555

BELGIAN VICINAL RAILWAYS.

In a notice as to last year's working of Belgian Vicinal (or Light) Railways, it was observed that "the receipts during the beginning of the present year (1897) show a tendency to increase in still greater ratio than those of 1896;"* and indeed the result has not belied that expectation. Last year the total receipts of all these light lines, from all sources, attained the figure of 7,939,433 frs. 80 c. (£317,577 7s.), against 7,055,591 frs. 25 c. (£282,223 13s.) in 1897, while the corresponding disbursements were 5,336,172 frs. 23 c. (£213,446 18s. 1d.) and 4,742,297 frs. 23 c. (£189,691 17s. 10d.) respectively: thus showing the mean coefficient of working to be 67·21 per cent. for the two years. Out of 9 lines that carry passengers and not goods, 8 show increased receipts, while there was only a falling off in those of the Ostend suburban service of the Ostend-Nieuport-Furnes Line; and out of the 58 lines which carry goods as well as passengers, 47 show an increase and only 11 a diminution in the receipts, there being an increase on the whole collectively, especially as regards passengers.

When the comprehensive project of these light lines—laid for the most part by the side of ordinary roads—was first started, there was a general fear that with the necessary relaxing of the precautions adopted on regular railways, accidents would be very numerous; but this fear has not been realised. Last year the total distance run was 7,980,597·84 kilometres (4,959,002 miles), showing an increase of 50½ per cent. as compared with that in 1891; and during this period the increase in the number of fatalities has only been 21·71 per cent., although that in the number of persons injured has been 75 per cent. Moreover, the accidents attributable to deafness, drunkenness, and suicide have appreciably diminished; but, strangely enough, accidents that have overtaken persons imprudently attempting to cross the line in front of a train in motion more than doubled last year as compared with 1897. Out of the 33 fatalities which occurred last year on Belgian vicinal

* See *Journal*, July 8, 1898, vol. xlvi., p. 718.

ailways, twelve were due to crossing the line in front of trains, nine to deafness, drunkenness, or suicide, six to attempts at entering or leaving a train in notion, two to circumstances not exactly determined, and occurring to persons neither travelling on the line nor engaged in the service, and one each to getting on to the platform railing, passing from one carriage to another, the work of shunting, and a train running off the rails.

Out of the 75 lines opened for traffic at the beginning of the present year (against 70 at the beginning of 1898), 43 show more favourable results of working, 42 paying a higher dividend last year than in 1897, and one of them showing a larger profit, which goes to set off previous losses, while in the case of another line, in the province of Luxemburg, its increased earnings have not only permitted of paying off past losses, but have even gone towards the payment of a dividend. There now only remain two lines that figure in the account "Loss in working;" and this loss, which was 62,166 frs. 92 c. (£2,486 13s. 6d.) at the beginning of last year, became reduced at its close to 51,067 frs. 46 c. (£2,042 14s.). Such loss, as well as future losses that may be incurred in working lines made in outlying districts that would in all probability, but for this powerful organisation, remain unprovided with railway accommodation for many a year to come, is abundantly provided for by the general reserve fund of the several lines, the total amount of which increased during the same period from 712,737 frs. 93 c. (£28,509 10s. 4d.) to 884,504 frs. 93 c. (£35,380 3s. 11¾d.) during the course of last year, and also the individual reserve funds of the several lines, the total amount of which increased during the same period from 468,136 frs. 36 c. (£18,725 9s. 1d.) to 589,669 frs. 66 c. (£23,586 15s. 9d.). Moreover, during the last three years not a single line of the 75 opened for traffic has incurred a loss; and, among the 69 lines that have been worked for more than a year, 31 pay a higher dividend than that guaranteed; nine a dividend of more than 3 per cent.; ten, one of more than 2½ per cent.; and eight, one of more than 2 per cent.

During last December, after the Société Nationale des Chemins de fer Vicinaux had been in existence about fourteen years only, the concession was obtained of the two-thousandth kilometre of line, an occasion which was marked by a spontaneous demonstration by the *employés* of gratitude to the general manager, M. C. de Burlet, who has held that post from the commencement, by a banquet given to all the functionaries and *employés*, at which several members of the Government were present, and by the distribution of substantial gratuities to all persons employed. At the beginning of the present year, after deducting two lines purchased by the State from the Société Nationale, the 94 lines conceded represented a length of 2,134·38 kilometres (1,325 miles); and of that number 76 lines, or sections of lines, representing a length of 1,643·63 kilometres (1,022 miles) are already in operation, while the remaining 18 others are either under construction or will be taken in hand very shortly.

Since the beginning of the present year the concession has been granted to the Society of six more lines or extensions, together 72·4 kilometres (45 miles) long, bringing up the number of lines to 97, and the total length to 2,206·78 kilometres (1,371 miles), of which 1,828·27 kilometres (1,135¾ miles) are laid to the gauge of one metre (3 ft. 3⅜ in.), 356·05 kilometres (221 miles) to the Dutch vicinal gauge of 1·067 metre (3 ft. 5$\frac{21}{32}$ in.), with a view to through working, and 22·46 kilometres (14 miles) to the standard gauge of 1·435 metre (4 ft. 8½ in.), where such lines effect a junction with standard-gauge railways, so as to be worked by the same rolling stock.

UNIVERSITY OF LONDON AND THE IMPERIAL INSTITUTE.

It having been agreed that the Government should take over a portion of the Imperial Institute for the purpose of affording increased accommodation for the University of London, a Treasury Minute giving effect to the proposals for this purpose has just been issued. From this it appears that the lease under which the buildings are held from the Commissioners for the Exhibition of 1851 will be transferred to the Commissioners of Works as representing the Crown, and the latter Commission will thereupon become responsible for maintenance, rates, custody, and protection of the buildings. The Commissioners for the Exhibition of 1851 have assented to this arrangement.

A portion of the western end of the building will be assigned to the Imperial Institute free of rent, and the eastern end and central portion will form the home of the London University. This arrangement will necessitate certain structural alterations which will be carried out by the Office of Works. The vote of £65,000 to carry out this arrangement was agreed to by the House of Commons, on Monday, 31st July, in Committee of Supply.

In answer to Sir Charles Dilke, Mr. Akers-Douglas explained that the money was asked for to purchase a portion of the Imperial Institute for the housing of the London University. The space which would be given to the University in the building would be far greater than was now enjoyed by that body; and in consideration for the transfer of the lease to the Office of Works, the Government would provide funds sufficient to pay off the existing mortgage of £40,000, and discharge the floating debt of £15,000. In addition to the cost of structural alterations, estimated at £7,000, £3,000 was asked for in the estimate for the maintenance and repair of the buildings and for the purchase of the necessary furniture.

As regards accommodation for the practical examinations of the University in physics and chemistry, it has been agreed that this shall be provided in the new buildings about to be erected for the Royal College of Science, subject to arrangement between the two bodies as to dates of user.

Obituary.

Sir Arthur Cotton, K.C.S.I., R.E.—General Sir Arthur Thomas Cotton, who died at Woodcote, Dorking, on Monday night, 24th July, was elected a member of the Society of Arts in 1873, and as far back as 1855 read a paper before the Society on "Public Works for India, especially with reference to Irrigation and Communications," which gave rise to much discussion. In subsequent years he read papers on "Indian Harbours" and "Indian Famines," and he was a constant contributor to the *Journal* of important letters respecting irrigation works in India, &c. He was born in 1803, a younger son of Mr. Henry Calveley Cotton, and cousin to the first Lord Combermere. He was one of a family of eleven brothers, several of whom served with distinction and attained high rank in the navy and army. One of these was General Frederick Cotton, who was Chairman of the Council in 1877. Sir Arthur was educated at Addiscombe, and in 1821 he entered the Madras Engineers, of which he was appointed colonel commandant in 1854. He served through the Burmese War of 1824-26, under Sir Archibald Campbell, and was present at the capture of Rangoon. In 1862 he became major-general, and the same year was made Colonel, Royal Engineers, with rank as colonel-commandant. He was made a lieutenant-general in the army, and placed on the fixed establishment of general officers May, 1867, and was appointed general in 1876, retiring the following year. He was knighted in 1861, for his activity in developing the cotton-growing capabilities of India, and was created a Knight Companion of the Star of India in 1866. Sir Arthur Cotton was devoted to the extension of irrigation works in India. In 1828, he was appointed to the charge of the Cauvery irrigation, and was also employed in the survey and improvement of the Paumben pass. In 1844, he carried out the systematic irrigation of the Godaveri delta. In 1858, he planned works for the Mahanadi delta, and was afterwards employed under the Government of Bengal to report upon water communication between the Ganges and Calcutta. In 1863, he reported on the Ganges Canal works, and later, projected works for the Sone irrigation.

Henry Maudslay, M.Inst.C.E.—Mr. Maudslay, a member of the Society of nearly fifty years standing, died on Tuesday, 18th July. He was the eldest son of Thomas Henry Maudslay, head of the firm of Maudslay, Sons, and Field (d. 1864), who was also a member of the Society. During the time that Mr. Henry Maudslay was a member of the firm he was created by the King of Portugal a Chevalier of the Order of Christ, in recognition of services rendered to the Portuguese Government. He subsequently spent much time in Palestine, and carried out some important excavations in Jerusalem at his own expense. He also rendered much assistance to, and frequently received the thanks of, the Palestine Exploration Fund. A large portion of the paving which he discovered in Jerusalem was presented by him to St. Paul's Cathedral, another portion being placed in Freemason's-hall. Mr. Maudslay was a past master of the Ironmongers' Company, a governor of Christ's Hospital, and a life governor of a great many hospitals and institutions. Mr. Maudslay was elected a member of the Society of Arts in 1852. He was a frequent attendant at the evening meetings, and often joined in the discussions.

General Notes.

Ecclesiastical Art Exhibition. — The twenty-first annual Ecclesiastical, Educational and Art Exhibition in connection with the Church Congress will be held at the Imperial Institute, October 7th to 14th next. One of the objects of this collection is to bring together representative specimens of Ancient Art, of a corresponding nature to those articles at present in use in our cathedrals, churches, colleges, &c., and thus to enable visitors to compare the old work with the new. Loans are solicited of ancient and modern goldsmiths' and silversmiths' work, ecclesiastical furniture, embroidery, paintings, drawings, carvings, photographs, books, manuscripts, and antiquities. The clergy and churchwardens of the diocese are particularly appealed to for the loan of communion plate and other objects of archæological interest belonging to their churches. A complete catalogue of the articles exhibited will be included in the "Illustrated Guide to the Congress and Exhibition," which will be published shortly before the Congress. A circular letter, signed by the President of the Society of Antiquaries and the Middlesex Archæological Society, and others, inviting contributions to the exhibition has been issued. The address of the Secretary of the Ecclesiastical Art Exhibition is Maltravers - house, Arundel - street, Strand.

Enamels that Co-expand with Metals.—The great difficulty hitherto experienced with cast or wrought iron objects coated with enamel is the unequal expansion and contraction of the two substances, this causing a splintering of the enamel; but M. Sagliot lately brought before the French Société d'Encouragement pour l'Industrie Nationale the results of his experiments in this connection, that have enabled him to constitute a whole series of enamels having various degrees of expansion. It appears that enamels containing cryolite, fluorspar, and a little rutile, or native titanic acid, possess very high degrees of dilatation, and that cast or wrought iron, coated with calcareous enamels containing no lead, which are not at all injurious, may be formed by using boric acid.

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FRIDAY, AUGUST 11, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS.

The results of the Examinations held at the end of last March have been published.

Copies for gratuitous distribution to each candidate who attended the examination have been sent to each centre. Additional copies can be obtained, price 6d. each.

The dates for the Examinations in 1900 will be Monday, Tuesday, Wednesday, and Thursday, March 26th, 27th, 28th, and 29th.

SECTIONAL COMMITTEES.

At the last meeting of the Council the following Committees for the Indian, Foreign and Colonial, and Applied Art Sections were appointed:—

INDIAN SECTION COMMITTEE.

Sir John Wolfe Barry, K.C.B., F.R.S. (Chairman of the Council).
Sir Steuart Colvin Bayley, K.C.S.I., C.I.E. (Chairman of the Committee).
Sir Frank Forbes Adam, C.I.E.
Lionel R. Ashburner, C.S.I.
Jervoise Athelstane Baines, C.S.I.
Sir Charles Edward Bernard, K.C.S.I.
Sir M. M. Bhownaggree, K.C.I.E., M.P.
Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.
H. M. Birdwood, C.S.I., M.A., LL.D.
Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.
Sir Charles H. T. Crosthwaite, K.C.S.I.
His Excellency the Right Hon. Lord Curzon of Kedleston, G.M.S.I., G.M.I.E.
F. C. Danvers.
Sir Juland Danvers, K.C.S.I.
Sir Charles A. Elliott, K.C.S.I.
Major-General Sir Frederic Goldsmid, K.C.S.I., C.B.
The Lord Harris, G.C.S.I., G.C.I.E.
Colonel Sir Thomas Hungerford Holdich, R.E., K.C.I.E., C.B.
Sir William Wilson Hunter, K.C.S.I., C.I.E., LL.D.
Sir John Jardine, K.C.I.E.
Sir Seymour King, K.C.I.E., M.P.
Sir W. Lee-Warner, K.C.S.I., M.A.
Sir Roper Lethbridge, K.C.I.E.
Henry Luttman-Johnson.
Sir Charles James Lyall, K.C.S.I., C.I.E., M.A., LL.D.
Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.
Sir James Lyle Mackay, K.C.I.E.
Sir Alexander Mackenzie, K.C.S.I.
J. M. Maclean, M.P.
General J. Michael, C.S.I.
Edmund Neel, C.I.E.
J. Sewell Neville.
Field-Marshal Lord Roberts, V.C., K.P., G.C.B., G.C.S.I., G.C.I.E.
Sir George Scott Robertson, K.C.S.I.
Alexander Rogers.
W. S. Seton-Karr.
Sir Charles Cecil Stevens, K.C.S.I.
Thomas H. Thornton, C.S.I., D.C.L.
Sir Charles A. Turner, K.C.I.E.
Sir Raymond West, K.C.I.E.,
Sir Alexander Wilson.
Arthur N. Wollaston, C.I.E.
W. Martin Wood.
Andrew Yule.
S. Digby (Secretary).

FOREIGN & COLONIAL SECTION COMMITTEE.

Sir John Wolfe Barry, K.C.B., F.R.S. (Chairman of the Council).
Sir Charles Malcolm Kennedy, K.C.M.G., C.B. (Chairman of the Committee).
The Earl of Aberdeen, G.C.M.G.
The Lord Belhaven and Stenton.
Lieut.-General the Hon. Sir Andrew Clarke, G.C.M.G., C.B., C.I.E.
B. Francis Cobb.
The Hon Dr. J. A. Cockburn.
Sir Daniel Cooper, Bart., G.C.M.G.
The Hon. Sir Malcolm Fraser, K.C.M.G.
Right Hon. Sir George Goldie, K.C.M.G., D.C.L., LL.D.
J. G. Gordon.
Major-General Sir William Henry Rhodes Green, K.C S.I., C.B.
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Miscellaneous.

THE GOBELINS TAPESTRY MANUFACTORY OF THE FRENCH GOVERNMENT.*

To this time-honoured institution the word "manufactory" is applicable in its strict literal sense, for the *artistes tapissiers* have raised their art to such a pitch that no engine or machine can in this case be substituted for hand work, as it has been nearly everywhere else; and the only pre-occupations of those who weave the precious fabrics are a love of the beautiful and a desire to attain the highest perfection.

In the East, from very remote times, fabrics were woven by a loom with vertical weft; and it is said that the Egyptians were the first to place the loom and weft in a horizontal position, for facilitating the manufacture of ordinary tissues, this latter arrangement having received the name of *métier de basse lisse*, in opposition to that of *haute lisse*, which is found at the Gobelins in its definite form.

According to Pierre du Pont, *maître tapissier* to Henri IV., the manufacture of tapestry began to be known in Europe about the 8th century, when some of the Saracens who had invaded the south of Europe introduced the carpet manufacture into France. Both carpets and tapestry were produced by private enterprise until the time of François I., who brought together the most skilful weavers he could find, and established them at Fontainebleau, under the direction of Salomon de Labaines, the King's weaver. Henri II., while maintaining the establishment at Fontainebleau under the direction of Philibert de Lorme, founded a new one in the Hôpital de la Trinité.

At the commencement of the 17th century, Henri IV. housed the weavers, Lorent and Dubourg, in the Faubourg Saint-Antoine, Paris, whence the manufacture was transferred to the galleries of the Louvre. At the same time the King brought from Flanders a party of weavers, under the direction of Marc de Commans and François de la Planche, who were installed in the Faubourg Saint-Marcel, in one of the houses of the Gobelin family, and near the dye works founded at the end of the 15th century by Jean Gobelin. This latter, a dyer of Rheims, had been induced to settle on the banks of the Bièvre, owing to an old tradition which attributed to the water of this stream valuable qualities for dyeing scarlet; and Jean Gobelin, with his son Philibert, remained at this spot during the end of the 15th and beginning of the 16th century, as is clearly seen from a passage in Rabelais.

The sons of Commans and de la Planche separated in 1629, Raphaël de la Planche establishing himself in the Faubourg Saint-Germain, while Charles Commans, and his children after him, remained in the house of the Gobelins until about 1654. A few years later, Jean Gluck, who brought from Holland a new process for dyeing scarlet, acquired the factory of the Gobelins (then occupied by a dyer named Chennevix, who had been a partner of Etienne Gobelin), so that in the middle of the 17th century the name of Gobelin was associated with both weavers and dyers.

On the other hand, the above-named Pierre du Pont, who about 1604 had invented the art of making Turkey carpets, was established under the patronage of Henri IV. in the galleries of the Louvre; and, in 1627, an ordinance of Louis XIII. granted him the manufacture of "all kinds of carpets and other works of the East, in gold, silver, silk, and wool" for 18 years. His apprentices, to the number of 100, were lodged in the Maison de la Savonnerie, at Chaillot; and in this ancient soap manufactory the first carpet looms were mounted by Lourdet, partner of Pierre du Pont. Accordingly, about 1662, while carpets were made at the Savonnerie, tapestry was produced at the Louvre and in the Faubourg Saint-Germain, the Hôtel des Gobelins then no longer containing weavers but only dyers; and it is at this period that Colbert bought the Gobelins buildings, to which were removed the old looms of La Planche and Commans, and whither were transferred the other weaveries of Paris. The Manufacture des Gobelins was thus definitely founded; and very soon this nucleus was reinforced by weavers from Maincy.

In 1694, when the war absorbed all the country's resources, the manufactory was closed; but five years afterwards work was resumed under the direction of Mansard, although only in the tapestry department. After that period, notwithstanding all the vicissitudes through which the country has passed during the last two centuries, never has there been cessation of work at the Gobelins; but during the Revolution the very existence of the manufactory was several times in danger. The workshops, which contained nearly 300 weavers under Louis XIV., only occupied 46 in 1797, the national manufactures being regarded as useless establishments, and many *chefs d'œuvre* having been destroyed at that period. The Consular Administration, however, re-established the system of apprenticeship, which had been suppressed, while also appointing a director of dyeing.

In 1825, the manufacture of carpets at the Savonnerie was suppressed; and the *basse lisse* looms of the Gobelins were sent to Beauvais, while carpet looms were put up in the vacant workshops, so that at the present day the weavers of the Gobelins manufactory produce the carpets and tapestries that are ordered entirely in looms arranged vertically. The internal organisation of the Gobelins had been ingeniously arranged by Colbert, the director having under his orders the foremen (*chefs d'atelier*), who

* "La Manufacture Nationale des Gobelins," by Louis Turgan, in *Les Grandes Usines: Etudes Industrielles en France et à L'Etranger.*" Paris: E. Bernard et Cie.

were at the same time contractors for the work, and fixing for each piece of work the amount to be given to the contractor, who paid his weavers. In order to ensure permanence in the colours, both wools and silks were dyed at the manufactory and handed over to the contractor, so that, the quality of the work being ensured, the weavers had an interest in producing, and the State knew beforehand the price to be paid for a piece of tapestry.

In 1792 the organisation established by Colbert was suppressed; and the contractors (now become foremen) with the artists (now *employés*) received a fixed remuneration. This system is still in force; and the salaries have been but little increased since, although the weavers are lodged in the manufactory and receive a pension at the age of 60. Since the foundation of the Gobelins, in 1662, there have been twenty-three directors, beginning with the painter Le Brun, followed by the painter Mignard between 1690 and 1695, while M. Gerspach, who was appointed Chef de Bureau des Manufactures Nationales in 1885, was succeeded, in 1892, by M. Guiffrey, the present director, an authority in all matters connected with weaving and tapestry.

During more than two centuries the buildings of the Gobelins manufactory remained just as they were under Louis XIV.; but the formation of the Avenue des Gobelins, the great fire in 1871 (when nearly 300 tapestries of inestimable value were destroyed), and works connected with the Bièvre, have partly modified their general appearance.

Visitors to the manufactory (which is opened gratuitously to the public, without formality of any kind, every Wednesday and Saturday) pass through the museum and three small galleries before entering the Atelier de Berri, which contains three looms, whence they descend into a second workshop, that has often been altered but never entirely re-constructed, where the famous Dutch weaver Jans worked in the 17th century. From this workshop, where there are now eight looms, a bridge gives access to the Atelier de la Savonnerie, where two looms suffice for the weaving of carpets, the others, now unoccupied, being veiled by admirable tapestries; and near to the Atelier de la Savonnerie is a third workshop for tapestry, containing two looms. Inasmuch as the number of weavers is now complete, the school of tapestry is without pupils, and the drawing school has been transferred to a new building.

Pupils are admitted to the elementary drawing school at the age of twelve, the instruction generally lasting two years; and from this obligatory course candidates are recruited for the school of tapestry. The education thus begun is completed at the École Supérieure and the Academy, the antique, the living model, and perspective, being subjects that are ardently pursued. It is chiefly in order to furnish recruits for the *ateliers* that the school of tapestry was established. The teaching is graduated, the pupils being first initiated into the use of the tools, after which they are set to execute bands of flat tints, with ornaments that become more and more complicated. After a year each pupil receives a premium of 100 francs (£4); and, if he passes the examinations satisfactorily, he is paid a salary of 600 francs (£24). After about two years a good pupil is able to begin work at the *Manufacture*; but it is only with long years of practice that a weaver completely masters the great difficulties of his art.

The Gobelins manufactory now consists of three distinct portions—the dye works, the tapestry *ateliers*, and the carpet workshops.

Preparing and Dyeing the Wool.

The dye works at the Gobelins, now under the immediate management of M. Guignet, are incontestably the most important in the whole world, not on account of the quantity turned out, which scarcely exceeds 6 cwt. of wool or silk yearly, but owing to the perfection and multiplicity of the operations; and these works supply the Beauvais as well as the Gobelins manufactory.

The wool, which for a long time came from the county of Kent, is now obtained from the national domain of Rambouillet, and on arrival at the Gobelins is classified according to its destination, and then, after examination by the foreman, is subjected to a scouring process, depending upon the colours which it is intended to receive. Passed cold through lime water or a carbonate of soda solution, the wools have more or less aptitude for receiving this or that dye, according to their origin and the nature of the scouring liquid. The operation of scouring must be watched with great care, especially as regards the carbonate of soda bath, the temperature of which should not exceed 50° Cent. (122° Fahr.), for fear of disintegrating the wool. The skeins, passed over long poles called *lissoirs*, are then plunged into one of the square coppers which contain the mordant, that must be kept at boiling point, after which the wool is subjected to the colour bath.

For producing, not only the many tints, but also the twenty or thirty shades of each tint, required by the manufactory, the dyers must be veritable artists; and at the Gobelins a point is made of producing colours *de grand teint*, *i.e.*, "fast," or permanent. The light shades are specially difficult to obtain; and a great many fine pieces of tapestry, that date from the commencement of the present century, are gradually losing their effect, owing to the decomposition of certain tints which have completely turned brown, while others have entirely lost their colour. Each tint at the Gobelins has its scale, or series, consisting of a certain number of shades, from the lightest to the most intense; and, although the difference between one shade and another is imperceptible to the ordinary eye, dyers distinguish them, not only when dry, but even when still quite wet.

When the colour is simple, the operation of dyeing is conducted in the following manner:—The bath is charged to the deepest shade of the scale, or series, desired; and the dyer, having placed on his poles the

skeins which he destines for the deepest shade, immerses them in the bath, examines them, takes them out, hangs them on uprights at his right hand, re-plunges them into the bath, again examines them, determines the length of time during which he should allow them to steep, or dry; and, when he considers that the skeins have been dyed to the desired point, he removes them and spreads them out, while, if necessary, he can again immerse them, although this must be avoided as far as possible.

During the work of the dyer the bath gradually becomes weaker, and it is renewed by degrees if required. As the impregnation of the liquid diminishes, the shades become so pale that the last appears white when compared with the first; and it is for these last shades that practised eyes and hands are required. While the wool has to be dyed strongly and deeply, the shade must be as light as desired, so that dyeing which attains this degree of perfection is a veritable art, requiring great intelligence and long experience.

The operations above described are often modified in practice. Instead of first taking the deep shades, a commencement may be made with those in the middle of the series, followed by the lighter shades; and, if they should not meet requirements, the skeins of wool are not lost, but are added to those intended for the deep shades.

The substances contained in all dye-stuffs dirty the baths, so that it is important to purify and renew the latter during the operation, and this with so much the greater care as the shades are lighter. When the colour to be obtained is a compound, like the greens, the browns, &c., the bath should be watched even more carefully, the colour which is most rapidly absorbed being renewed if necessary. All these operations are carried on at the Gobelins, in a laboratory rather than in a workshop.

During the last few years some aniline colours have been tried at the manufactory; but, in presence of manifestly unfavourable results, a return was made to the old products and traditions, indigo being used for the blues, woad for the yellows, madder and cochineal for the reds. The colours are even more brilliant than before, because pure substances and improved methods are employed, while the permanence is as great as ever. There are, however, no secrets at the Gobelins, all the receipts being registered and communicated to anyone who asks for them.

When the wools are dyed, washed, and dried, they are passed on to the storehouses, or are sent to Beauvais with the silks, which are largely employed at that establishment, and which are also dyed at the Gobelins manufactory. The wools keep perfectly well for several years; and when they are to be used they are rolled tightly into balls, and then mounted on spools or spindles (*broches*), which the artist-weaver chooses, just as a painter prepares his pallet. In the general storehouse of the tapestry ateliers there are about 11,000 bobbins of wool, and 7,500 bobbins of silk; but all the series of colours have not the same number of shades, some of them having eight, and others as many as thirty-six. In the detail storehouse, where the weavers go for their supplies, there are about 34,800 spools of wool, and 6,000 of silk, while another storehouse contains the unclassified wools and silks.

Tapestry Weaving.

In the tapestry department, which has been managed by M. Munier since 1889, forty-five artist-weavers and pupils are engaged on the different pieces, working exclusively, as has already been stated, *en haute lisse*, *i.e.*, vertically, although this method of manufacture is scarcely employed elsewhere than at the Gobelins. Works produced in this manner are generally considered superior, the execution being slower, although at the same time more perfect on account of the position of the loom; but it must be admitted that there is great difficulty in distinguishing products of the *haute* from those of the *basse lisse*. At the Gobelins are chiefly executed large decorative panels, with human figures, of 20 or 30 square metres (mean 269 square feet) area, which do not require such minute work as, for instance, depicting a bouquet of flowers for a chair seat.

Two of the three *ateliers*, containing, one three, and the other two looms, 4 m. by 7·5 m. (13 ft. × $24\frac{1}{2}$ ft.), may be visited by the public; and, excepting two of the looms, which are of iron, they are made of wood, being absolutely identical with those used in the 17th and 18th centuries. Two strong uprights, called *cotrets*, carry two large horizontal rollers, that have received the name of *ensouples*, which are made of oak or deal, and have at each end pivots turning freely in bearings, that may be shifted vertically in the groove of the upright. While both rollers revolve on their axes, it is generally the upper one only that is susceptible of vertical displacement. The iron looms, similar in general arrangement to those of wood, have among other advantages that of greater rigidity.

The *chaîne*, or vertical web, in tapestry consists of woollen or cotton threads perfectly vertical, parallel and equi-distant, stretched on the rollers; and, in a groove extending the whole length of the rollers, there is a small wooden rod, called *verdillon*, for fixing the threads. When it is desired to roll up or unroll a portion of tapestry in course of execution, the rollers are rotated by means of levers inserted in holes made for the purpose; and, as the web is thus wound up on one of the rollers while being unwound from the other, the work is always executed at the same height. A little extra tension is given by an iron set-screw contained in the uprights, and acting on the roller bearings, while the rollers are locked in the position given to them so as to prevent their unrolling.

It is stated above that the threads of the *chaîne*, or web, are stretched vertically and in the same plane; but this is only the case to a certain extent, because they are passed alternately over what is called a

bâton de croisure, which is generally a glass tube one inch in diameter, while a string passed alternately between the threads contributes to maintain their distance apart. The threads are, therefore, in reality, divided into two sheets, those on the weaver's side being the *fils d'arrière*, and those in front of the loom being the *fils d'avant*. Over each of the latter threads are passed strings, designated *lisses*, which have the form of rings, and are carried at the other end by a strong pole, called the *perche des lisses*.

The weaver takes his stand behind the loom, with his back turned to the copy (*modèle*), of which he first takes a general tracing, in order to fix the position of certain points sufficiently far apart, the actual contours being drawn in full lines, and the principal tones being designated by dotted lines. This tracing is placed against the back threads of the web; and, with a small wooden style, previously inked, the artist traces upon the weft, thread by thread, the indications he has taken from the copy, the details being put in as the actual work proceeds. Although it is necessary to take these precautions, which permit of executing the work more correctly, too great reliance must not be placed upon them, as the threads become more or less displaced during the course of the work, and perfectly adventitious causes may modify this or that portion of the whole. The artist thus marks out his work; but he is chiefly guided by his artistic sense and the experience he has acquired.

The artist-weaver, who has at hand a great many spools with wool of various colours and different shades, takes one of these spools, after having determined the shade from his copy; and then he sets the end of the woof thread on the weft thread, to the left of the space where the shade is to be placed. He passes the spool from left to right, between the front and back threads, after separating with his left hand the threads that he desires to cover; and with this same hand he then draws towards him the front threads by means of the *lisses*, or strings in the form of rings, while with the right hand he passes the spool backwards from right to left, thus drawing along the woof thread, which he presses against the previous one with the point of the spool. This stitch, which is called *duite*, is all the mechanism employed; and the two operations which constitute it arrange the woof thread alternately at the front and back of the weft threads, while crossing itself between each of the latter threads.

The *duite*, or stitch, may be made with a single weft thread, or with any number of them that the hand is capable of taking in; and, when finished, it is pressed down with a kind of strong comb the teeth of which, passing between the threads of the weft, close up the woof in such a manner as to conceal the weft threads, although if the stitch should happen to be short it is simply closed up with the point of the spool or the middle finger of the right hand. It is by means of these *duites*, or stitches, that the weaver depicts the design upon the weft, but in lines; and he has in front of him the wrong side of the fabric, on which side he cuts, sets off, and dissimulates the ends of the threads that begin and finish the stitches. It is the shades that determine the number of weft threads to be comprised in a stitch; and in a horizontal portion of uniform tint the stitches are made as long as possible so as to hasten the progress of the work. In the small details, however, it often happens that a stitch only includes two or three weft threads, the contours of the design to be reproduced, the various circumstances of the colouring, the greater or less extent of the lights and of the half tones determining the length of the stitches and also their number. Transition from lights to browns and from one tone to another is made by colours partaking gradually one of the other and arranged in hatchings. The contours determined, or formed, obliquely to the direction of the weft by the various lengths of the stitches are not, for the most part, either rectilineal or regularly curvilineal, but always *dentellé*, or toothed. This arrangement, however, owing to the fineness of the woof threads, has no disadvantage whatever as regards the general effect of the objects represented, disappearing in the details of light and shade, and also in the hatchings, which are employed to graduate the tints, and also for avoiding the mosaic effect that would result from a simple juxtaposition of colours.

"La Rentraiture."

This term is applied to all subsidiary work with the needle connected with tapestry, such as sewing together the various portions of a new work, and also the repairs made to worn or faded tapestries, while sometimes the borders are not woven on the same loom as is the tapestry, so that the two have to be united. All these operations, which are executed with great care and skill, are entrusted to a *maître rentrayeur*, having under him several workmen and workwomen.

When the work to be repaired has any break of continuity, such as a hole, the weft must be reconstituted by attaching new threads to the old that remain; and then, instead of passing the thread into the woof with a spool or spindle, the work must be continued by the needle. If however, the missing part is of large size, it is often more convenient to weave it in the loom and then insert it in its place.

All factitious methods for restoring old tapestries are strictly forbidden at the Gobelins Manufactory, for instance, that of scraping the wool and painting it with appropriate colours for restoring the original tone. The Atelier de Rentraiture besides doing work to tapestries belonging to the State, also undertakes repairs to those contained in private collections, and entrusted to the Gobelins for that purpose.

Carpet Weaving.

The carpet *atelier*, managed by M. Jacquelin, after having occupied nearly forty weavers in 1860 now employs only ten, because during the last few years the vacancies caused by decease, pensioning off and

departures have not been filled up; but attempts are now being made to restore to this branch of the manufacture its former importance.

The weaving of carpets differs entirely from that of tapestry, the tissue produced by the artists of the Savonnerie being a pile, the weft of which is wool and the woof of very strong hempen threads. The looms are the same as for tapestry, although of larger dimensions—one has just been put up that is 12 m. (nearly 40 ft.) long—and the artist, placed in front of his loom, works on the right (face) side of the work, having the copy (*modèle*) above him, while the wool employed generally consists of five threads, having different tones but equal value, that harmonise.

For making the stitch the weaver, having chosen his spool, takes with the fingers of his left hand the weft thread on which he has to commence, and draws it slightly towards him, while passing behind it the spool with wool thread which he holds in the right hand; and he then draws towards him, by means of the *lisse*, or string in the form of a ring, the next weft thread placed a little behind the first, surrounding the latter with a slip knot which he draws tight. Between these two passes the woof forms, in front of the weft, a ring the amplitude of which depends upon the height of the pile; and a round iron rod terminating in a blade, inserted in this ring, occupies a horizontal position, and becomes charged in succession with a series of wool rings formed by repeating the stitch, each knot being pressed down and tightened upon the tissue with the thumb and fore finger.

The act of withdrawing the *tranche-fil*, as it is called, from left to right cuts the wool rings; and, when a row of stitches is thus made for a certain length, they are joined together by two very strong hempen threads, passed between the two sheets (*nappes*) of the weft and superposed at the points. This would not suffice, however, to form a strong fabric; but it is necessary to tie together the threads of the weft with another hempen thread forming woof. For placing it in the tissue the weaver brings the hind threads forward, passes the woof between the two rows of threads, presses it down with the comb, and then allows the hind threads to return to their position, taking care to allow this woof sufficient slack to permit its following all the inflections of the weft threads. In this manner the stitches are fixed, as it were, when the weaver presses down with the comb the stitches and the hempen threads, which latter enter into the fabric, becoming quite hidden therein.

The ends of wool thread are then picked apart by means of the needle (*aiguille*), in order that the contours may be well defined, after which the ends of the wool threads, previously cut by the *tranche-fil*, are sheared; and then, by means of scissors with curved —or rather cranked—handles, guided by a small board, the artist again shears the pile with great regularity, when he is able to judge of the effect produced by his work. In the kind of mosaic thus formed, of which the coloured particles are the ends of infinitely small wool threads, the material is seen in section, instead of lengthwise as in tapestry; and, as the wool threads are perpendicular to the weft, they are flexible—a disadvantage inseparable from velvet pile, which should be borne in mind when choosing subjects for reproduction, because the least pressure may put the lines out of form.

Museum and Works in Hand.

Temporary exhibitions have been held from time to time in the galleries arranged for that purpose; but it was not until 1885 that the museum was definitely organised, containing tapestries spared by the fire in 1793, 1797, and especially 1871; gifts from the State or individuals, and also works purchased, while all the *genres* and every epoch are represented.

Among the most ancient pieces there are 236 Copt tapestries, that were discovered in Egypt; two ancient Chinese tapestries, one representing a stag and a doe, and the other a ram and a sheep; a cushion cover of the German school, dating from the 14th century; the Miracle du Landit, a Flemish tapestry from the Château du Plessis-Macé, and the Idole, all three of the 14th century; the Annunciation, and the Adoration of the Magi, both of the 15th century, that were bequeathed by M. Albert Goupil; Louis XI. raising the siege of Salins, remarkably well preserved, though dating from 1501; the Concert and the Shepherds, terminated a few years later; the Wild Boar of Calydon, the Ascension of Elijah, and Abraham's Sacrifice, that were woven in Paris at the beginning of the 17th century.

Owing to want of space, some curious fragments of tapestry, not woven, but embroidered, have been hung temporarily over other tapestries; the portrait of Louis XIV. after Rigaud, has been placed on an easel in the first gallery; and a great many hangings are scattered about in the passages, in the ateliers, and in the chapel; Venus at the Forge of Vulcan, after Boucher, a *chef d'œuvre* of the 18th century, is now exhibited at the entrance to the Atelier du Nord; and The Entrance of the Turkish Ambassador to the Tuileries is arranged on one of the vacant looms of the Savonnerie.

The ateliers themselves constitute, especially at the present time, the most magnificent museum of modern tapestry, because the subjects and the copies (*modèles*) are most various, while their execution has attained the highest perfection.

Financial difficulties from the beginning of the 18th century prevented commissions being given to artists specially producing decorative paintings; and a beginning was made by re-copying the works of Le Brun, and afterwards other paintings. Very soon the painters to whom commissions were given, when that was possible, quite ignored the exigencies of weaving; and the tapestry artists gradually accustomed themselves to the new *genre*, multiplying the shades, and producing exact copies of the paintings, after which there was a reaction, the late M. Turgan writing:—

"Some are of opinion that the present method of working with judicious slowness should be maintained, and others that an attempt should be made, as far as possible, to apply the best methods now invented for simplifying hand work, the execution being hastened and the cost diminished. The former think that the productions should consist of paintings that are the most difficult to imitate, in order to maintain the distance which separates the work of the Gobelins from that of commercial establishments; and the latter, on the contrary, opine that all idea of reproducing paintings should be abandoned, but that attention should be exclusively turned to the production of splendid hangings, ornamented with arabesque flowers, and enriched with the precious metals."

During the last few years the intentional imitation of painting by tapestry has been abandoned, at any rate, in principle; and now account is taken of the essential structure of tapestry, the minutely fluted surface of which cannot render either a straight line or a circle, the lights of which have always a little shade, and the shades a little light, special subjects being created that may be executed with a small number of shades. Most of the pieces now being executed are conceived in this spirit, being veritable mural hangings; and the intended tapestry effect is evident at the first glance, "Le Tournoi," after J. P. Laurent, "La Mission de Jeanne d'Arc" and "Le Départ de Jeanne d'Arc," serving as types of this school; but such tendency is less evident in "La Justice Consulaire," of Maignan, "La Renaissance," of Ehrman, and the "Mariage Civil," of Claude.

A replica, or perhaps rather second edition, of the tapestry after Viger Lebrun, "Marie Antoinette et ses Enfants," is now being executed as a present to the Empress of Russia; and there is every indication that the second will be superior to the first copy, which was woven at the beginning of the century. In the same atelier some of the artists are engaged upon Leloir's "Roman au XVIII.me Siecle," and others on Boucher's "Aminthe et Sylvie." In the Atelier de la Chapelle a work of Gustave Moreau, "La Sirène et le Poète," is being reproduced by way of experiment, because of the great difficulty attending the reproduction in wool of such a detailed and elaborate painting.

While the production of the Gobelins manufactory increases every year, the execution remains at least as perfect as ever, if indeed it be not even more perfect; and, at the present time, great activity reigns in this "Dernier refuge d'un des arts somptuaires les plus magnifiques."

COAL DUST IN MINES.

The *American Gas Light Journal*, quoting from *Mines and Minerals*, says that by the term dust is meant small particles of solid matter that have surfaces so large in proportion to their contents that they are easily suspended in moving air. Some dust particles are so small that after they have been raised by a relatively slow current of air, they are slow to fall again when the current motion has ceased. There are other dust particles so large that they are lifted only in swift air currents that move with hurricane velocities. Between these extremes the gradations in size are so great in number that their classification has never been attempted.

Coal dusts, in common with the dusts of other solids, are of various sizes, and are found deposited in situations where the current velocity of the air is too low to support them; for example, on the haulage roads in coal mines the large particles that are only suspendable in rapid air currents, such as are set in motion with the swift moving cars, are always found on the floor, while the lesser particles of constantly decreasing size are found at increasing elevations on the projections of the sides, until the top timbers are reached, where on the upper sides are found the impalpable particles that only fall in air that has ceased to move.

In all situations the deposition of dust particles is subject to the common law. "The contents of dust particles are proportional to the velocity of the air movements that suspend them." The largest particles of dust are only suspendable in rapid air currents, and the minutest particles are the only ones that are suspendable in air that has no true current motion, but only an eddy motion, such as is found in a closed room where minute dust particles are seen dancing in a sunbeam.

The gradation of dust particles with reference to the air movements by which they are suspended is especially important with regard to the inflammability of coal dust when suspended in the air of mines. The following propositions are indisputable, and being so, they furnish the facts by which it can be proved that the dust that is suspendable in nearly still air is more dangerous than that which is only suspendable in air currents moving with relatively high velocities. First, large particles of coal can only burn slowly, as the oxygen required for their combustion can only be supplied by converging streams of air that lie in the radii of spheres whose contents are proportional to the contents of the coal particles; this means that a given sphere of air contains the weight of oxygen required for the perfect combustion of a particle of coal.

Some idea of the volume of air required to burn up one of the large particles of dust that are suspendable in a rapid current of air, may be obtained when it is shown that a sphere of air 1·5 inches in diameter is required to supply the necessary oxygen. Experience and observation have shown, however, that such dust is never all consumed, for when it is examined after an explosion has occurred it is found to be coke that has been separated from the volatile matter of the coal.

For particles of dust to be perfectly consumed in a fraction of a second of time by the oxygen contained

in spheres of air 1·5 inches in diameter, the velocity of the air converging on the particle of dust would have to be such as cannot be attained, because the necessary motive force is never present to do it.

For coal dust in air to cause an explosion, the heat developed by its almost instantaneous combustion must be sufficient to raise to the temperature of flame the air that contains it. Large particles of dust cannot produce an explosion, because the period required for its complete combustion is too long. Very fine dust, such as is suspendable in nearly still air may, however, cause an explosion, for the following reasons: (*a*) The areas of the surfaces of small particles are much larger in proportion to their contents than those of large particles. (*b*) The disengagement of volatile matter from dust particles is proportional to their surfaces divided by their contents. (*c*) The combustion of the volatile matter disengaged by small particles requires shorter periods than does the volatile matter disengaged by large particles, because the air and the gas are more intimately mixed when ignition occurs.

It may now be safely affirmed that large dust, such as is suspendable in swiftly moving currents of air, is not explosive, and that the only dust that can be consumed in a period of time sufficiently short to raise the air in which it is suspended to the temperature of flame is the fine small dust found in nearly still air. This does not, however, solve the problem of dust explosions, for, admitting that it is only the smallest particles of dust that can supply the combustible requirement of a dust explosion, an important query still remains unanswered, namely: How does the force act that makes the air streams advance on a burning particle of coal dust? The answer is, the air streams within an imaginary sphere do not exist, and, therefore, the force by which the air supply is maintained must be sought for elsewhere.

It has been noticed that the dust found in mines after an explosion consists, wherever the fire has been, of particles of coke that can only have been produced at such a temperature as would be generated by the burning of inflammable matter such as the gases given off by coal, when it is heated.

It is evident from this occurrence, that in such cases it is not the fixed carbon but the volatile matter of the dust that is the cause of the rapid ignition that makes coal dust in air explosive. Again, as no propelling force is present in the air to direct converging streams to the burning dust particles, the means for supplying the required oxygen must be sought for in some other way.

When coal is heated above the temperature of water boiling at 212° F., it gives off inflammable gas, and when the temperature is still further raised, the gas is disengaged with increasing rapidity. Consequently, every particle of dust when heated will project into the surrounding air little jets of gas that will mix with the air and make the required explosive mixture that will, when it is a maximum one, consist of nine and a half volumes of air and one volume of gas, as truly as any other maximum explosive mixtur of gas and air. Granting the accuracy of this conclusion many things that are otherwise inexplicabl in the behaviour of coal dust when experimented with become intelligible; for example, the charge of dus in air will sometimes be insufficient to disengage sufficient gas to make an explosive mixture; and at othe time the charge of dust will be so high as to disengag when heated an excess of gas. At other times th dust particles in a swift current will yield gas to slowly.

To illustrate these conclusions, suppose, after th manner of the experiments of Mr. Henry Hall, th English mine inspector, that dust of different sizes i let fall in a mine shaft in which the air has no curren motion, and that half way down the shaft a larg flame is kept burning. Two things would happen first, the velocities of the falling particles would b somewhat proportional to their sizes and no ignitio or explosion would occur until the arrival of som particles that were among the smallest, and wer present in just such a charge as would disengag sufficient gas to make a sheet of flame that would fil the shaft when ignition began.

The question here arises, in which portion of a coal mine is the air most likely to be dangerously charged with the class of coal dust that would make an explosive mixture under conditions favourable to it ignition? Such a place is a room in a bituminou mine or chamber in an anthracite mine. All room cannot, however, be equally subject to the dangers o dusty air; for example, the first room on the incoming side of a panel will receive clean, uncharged ai and should a shot blow out at any time no explosio can occur, because the dust normal to the face of th room will have been carried into the room on th return side of it before the shot was fired. Th danger of dust charges in the air will, howeve increase until the last room on the return side of th panel is reached, for then it is not possible for clea air to enter such a room unless the air has been previously purged.

Dust explosions are generally associated with blown out shots, or air that contains a small percentage o marsh gas. It is also a matter of common experienc that coal dust makes a mixture of gas and air explosive that would not otherwise be so, but these experiences do not explain why an ordinary lamp flame wi not ignite a dust charge that becomes explosive in th presence of a blown out shot. What supplies th efficacy of a blown out shot is not so much its grea heating power as its percussive action, for this quickl diffuses the heat and quickens combustion.

In the same way the effects of an explosion of ga are vastly magnified by the presence of coal dust i the air of a mine, for once the air and gas explode the compression of the air in the neighbourhood o the initial explosion intensifies and quickens the combustion of the dust it contains, until the extent of th fiery blast is many times increased.

Where danger from the presence of coal dust lurk

a mine, the air entering a room in which a shot is to be fired should be cleaned by a water spray ed in the cross cut through which the air enters.

It is possible that very fine coal dust may, without sengaging gas, burn with sufficient rapidity to use an explosion, as such coal is subject to oxida- on, but hitherto very little coal dust has been met ith that was sufficiently quick in the diffusion of me to justify the conclusion.

OMMERCIAL EDUCATION IN RUSSIA.

Commercial education is continually receiving more tention and encouragement in Russia. Not only e Government, but also commercial institutions, rge firms, and even private individuals, are opening w commercial educational establishments, varying om the engineering college (polytechnic) opened by e Government at Warsaw last year, where young en who wish to become civil, mechanical, chemical, r electrical engineers, architects, or surveyors, can btain a thorough, theoretical, and practical technical ducation, to the simple evening artisans' class, esigned to give apprentices a certain amount of heoretical knowledge of their trade to supplement he practical knowledge gained at their work. onsul-General Murray says that between these two xtremes come commercial schools, where boys can et a thorough commercial education as clerks or ommercial men, and artisan schools, where the sons f working men can get a preliminary education at ertain trades, such as carpentering, locksmiths, &c. t thus only remains for the parents, and the boy imself, to decide what line he will take, and how uch time can be given to his education, for which acilities are at hand from the time he first goes to chool until he has finished at the engineering college t 22 or 23. The two branches of commercial ducation which appear to be the most neglected, as ompared with Germany, are shorthand, it being xtremely difficult to get a clerk who can take down letter in shorthand, and then print it off on the ypewriter, so common an accomplishment elsewhere, nd the careful special training of commercial ravellers, which is carried to such a pitch of per- ection in Germany, has little attention paid to it in Russia.

TOBACCO CULTIVATION IN ITALY.

The province of Lecce has for a long time past been considered as peculiarly indicated from the haracter of the soil, as well as its climate, for the ultivation of tobacco, and rightly so, as good quality eaves are certainly produced, and the so-called "Lecce" snuff which is sold in small drums, not nlike a diminutive Smyrna fig drum, has long been avourably known to snufftakers. Consul Cocoto in is last report states that under the preceding Governments the cultivation of tobacco was almost free of restriction, but since Italy has become a first-class power the production and sale alike of salt and tobacco has become a Government monopoly, with the result that the plant is grown only under certain restrictions and with the constant surveillance of the Government department to which the monopoly is attached. The enormous increase of late years in the use of the cigarette has rendered it necessary for the monopoly to provide this article in its various varieties in constantly increasing quantities, and some few years back efforts were made to cultivate the form of the tobacco plant grown mostly in Turkey. With this end in view the department sent a quantity of seedling plants to Lecce for experimental purposes, and as the experiment gave favourable results the plant has been gradually introdnced in substitution for other qualities which were formerly grown in the district. It appears that one of the principal conditions of success in the growing of this delicate quality of tobacco is that the land be exclusively manured with ovine matter, and on landowners it was specially enjoined that none but sheep dung should be used by them in the cultivation of the "Oriental" tobacco plants confided to them by the department. The result of the crop has, it appears, been disappointing; cigarettes made from the leaves grown in the province of Lecce have proved defective, the tobacco was not aromatic, and would not keep in some cases, which the department attributed to insufficient manuring, or the total absence of manuring, whilst in the case of other parcels, the smell was altogether offensive, which was attributed to the plants having been manured with ordinary farm manure, and not the special manure indicated by the department. Matters have been brought to a head by the department announcing that unless landowners fulfil the conditions imposed on them when accepting the cultivation of the plant for account of the Government, it will become necessary to discontinue the cultivation of Oriental tobaccos in the province. The President of the Chamber of Commerce recently called a meeting, at the county town of Lecce, of the various landowners interested in the cultivation in question, and, after a long discussion, on the proposal of the Mayor of Lecce, a memorial was unanimously adopted by the meeting, attributing the bad results complained of by the department to the fact that the price which the producer receives from the department when grown rendered it quite impossible for ovine manure to be exclusively used, inasmuch as the manure in question was not obtainable in any quantity, there being no inducement held out to rear sheep in the district. The meeting further deliberated that the extension of land now admitted to tobacco cultivation be increased, the prices paid be increased, the classification of the produce to be less rigorous, particularly as regards the "Oriental" qualities, and that the Government institute an ambulatory professorship to further instruct growers as to the best means of growing the tobacco plant.

This incident is of recent occurrence, and the result is so far unknown. Consul Cocoto says that it is to be hoped that a compromise of some kind will be arrived at, so that the province shall not lose this most important industry.

FOREST AND MINERAL WEALTH OF THE SOUDAN.

The following information, extracted from a report by Sir William Garstin, K.C.M.G., on the Egyptian Soudan, received by the Foreign-office through H.M. Agent and Consul-General at Cairo, is taken from the *Board of Trade Journal.*

A very possible source of future wealth to the Soudan lies in the vast forests which line the banks of the Upper Blue Nile and extend, in an easterly direction, to the Abyssinian frontier. In the Bahr-el-Ghazal province also, particularly in the Bongo country, large forest tracts exist.

The ebony tree (*Dalbergia melanoxylon*) is met with south of Karkauj, on the Blue Nile, and again in the vicinity of the Sobat River. This tree does not, in these latitudes, attain to a very large girth, nine inches being apparently its maximum diameter. It must, however, be very common in these forests, as most of the principal houses in Omdurman are roofed with it. The value of *Acacia arabica*, from which the white and red gum is obtained, is well known; while the other kinds of acacia, such as *Acacia nilotica* (in Arabic "Sant"), is the chief source of the fuel supply.

A bamboo is met with in the ranges of hills to the south of Famaka, and, according to some, "mahogany" is found in the forests round Fazogl and in the Beni Shangul country.

The means of transporting such woods can only be by the river. Unfortunately, neither the ebony nor the acacia will float in water, and, therefore, such transport is debarred in these cases. If a good and serviceable timber tree can be discovered in the Blue Nile forests which can be floated down the river to Egypt, a large source of revenue will undoubtedly have been found. Extensive saw-mills might be erected at Assouan, utilising the power available at the dam now under construction, and an important timber trade might one day arise.

On the White Nile, in the Bongo and Rohl districts, the india-rubber creeper (*Landolphia florida*) is found in great profusion. If the rubber yielded by this creeper be not of quite so good a quality as that obtained from the Assam india-rubber tree (*Ficus elastica*), it is still of sufficient value to be counted as an important asset in the future trade of the Soudan. This plant, which has large laurel-shaped leaves, and a white flower resembling a jasmine, requires severa years to mature before yielding rubber in any quantity. The natives obtain what they require by tapping the stem, usually in such a reckless manner that the creeper dies under the operation. The Assam in rubber tree should certainly flourish well in most pa of the Soudan, more particularly south of Kharto Although this tree takes from twenty to thirty ye to arrive at a girth sufficient to permit of regu tapping, its yield is so valuable (about £3 per t per annum) that its introduction into the countr well worth attempting.

It is very much to be hoped that a scient examination of the Soudan forests may ere long carried out under the superintendence of an expe An Indian forest officer (from Burma for choice) mi be deputed for this purpose. It is certain that m valuable information would be obtained from report. Such an appointment needs no recommen tion—its necessity is obvious. A trained forest offi could, moreover, render good service by advising Government as to the best method of preserving valuable fuel supply which at present exists on banks of both rivers. This supply, although ap rently inexhaustible, must speedily diminish, unless cutting and felling of the areas is carried out up some regular system which will permit of the you trees growing up and replacing those cut down. is, of course, inevitable at present that the felli should be carried out in a wasteful manner. Fatig parties are landed from the boats, and are required cut the largest amount of wood in the short possible time. The men have no idea of the value the trees, and naturally select those which are near to the water and easiest cut. Should this practice continued, it is certain that a few years must se great diminution in the belt adjacent to the river. the Blue Nile even the valuable gum-produci acacias are being felled for fuel.

Minerals.—Very little is known regarding t possibilities of mineral wealth in the Soudan. Un the country is more settled, an investigation of t mountainous regions of Kordofan and Darfur on t west, and of the Abyssinian frontier on the ea would be impossible. Iron ore is found in the Bah el-Ghazal province, and also in Darfur; while go mines were at one time worked in the mountai south of Fazogl. Could coal be discovered, it wou make a great change in the whole question of t Soudan. In a few years' time it is probable that t Geological Survey Department of Egypt will be ab to depute parties to examine the Soudan. For t present nothing can be done.

THE PREPARATION OF VERMOUTH I FRANCE.

The manufacture of vermouth in France is confine almost exclusively to the city of Marseilles, where a the important manufactories exist. The article made from ordinary white wine, which is produce extensively in the region of which Marseilles is th principal centre, and which on account of it

undance is very cheap. A pure wholesome white ne may be bought in the South of France at an ceedingly low price. While returns showing the oduction of wine in France are published every ar by the Government, no statistics are kept conrning either the production, consumption, or exrtation of vermouth. The two principal points in irope from which vermouth is exported are Marilles and Turin. Vermouth, according to the nited States Consul at Havre, is simply an infusion certain plants and bitter aromatic herbs and roots a quantity of wine, the degree of which has been engthened by the addition of one-ninth of its bulk alcohol, in order to bring the wine, which is usually not more than 10° alcoholic strength, up to 15°. ie alcohol used should be pure, clear, and about 85° in strength. The following are the gredients of ordinary French vermouth:—Dry iite wine, muscatel wine, wormwood, bitter ange peel, camomile, water germander, Florenie iris root, centaury, Peruvian bark, aloes, mamon, nutmeg, alcohol at 85°, and rasprry juice. The herbs and other ingredients are metimes allowed to remain in the wine for a period two months, the solution being stirred every fifteen ys. After the expiration of two months the wine drawn off into another barrel and is allowed to nain therein for two weeks, after which it is drawn a second time. In the event of the vermouth being oudy, which is often the case, the manufacturer sorts to the simple process known as *collage*, which nsists of stirring in some boiled milk in the prortion of one pint to 26 gallons of vermouth. The iite of a single egg, well beaten, for each 26 gallons, about half a fluid ounce of fish glue, is also used this purpose. The vermouth should be allowed remain in the barrel for about five days after the *lage*, after which time it may be drawn off and ered. If the vermouth thus made is not sufficiently eet, a little sweet wine or syrup may be added. Its gree of sweetness, however, should not exceed 5° to on the Beaumé scale. Newly made vermouth has flavour of herbs, which is occasionally a little too onounced. Age alone causes the disappearance of s. Certain manufacturers, instead of putting the rbs and other ingredients directly into the barrel, st inclose them in a linen sack, which is then spended in the barrel of wine. The sack is hdrawn every five or six days, the liquid exssed from it into the wine, and the sack again pended. It is left in the wine for a month, at the l of which time it is taken out, all the liquid ssed out of it, and the fluid thus expressed returned the barrel. Other manufacturers first make an oholic extract of the ingredients, which extract is erwards mixed with the wine in the proportions en below. To obtain the alcoholic extract referred it is but necessary to reduce the dry ingredients ntioned to powder, and to place the same in about to 12 quarts of alcohol of 85° strength. The ution is allowed to remain standing for a week, after which 19 quarts of alcohol, and 7·35 quarts of white wine are added, together with the herbs cut into small pieces. The solution is then warmed in a water bath, which should not be heated above 140° Fahrenheit. After half an hour's warming it is removed from the fire, allowed to cool, and to remain standing for eight or nine days, during which time it should be frequently stirred in order that the sediment may be brought as much as possible in contact with the liquid. The solution, when perfectly clear, is placed in a large glass vessel, and forms an extract of vermouth. To make the article of commerce, 1·58 quarts of the extract are mixed with 2·11 quarts of white wine. If, in the simple process of infusion first described, the addition of alcohol to the wine precipitates the tartar contained in the latter, and causes cloudiness, the solution should be allowed to stand a few days until it clears, after which the solid ingredients may be added. The quality of the vermouth manufacture in France depends in a great measure upon the sort of wine used. The wines most employed are those of the valley of the Rhone, certain Spanish wines, and the wines of the extreme South of France. There is a difference between the French and Italian vermouth. A number of French manufacturers make Italian vermouth, however, not for the purpose of deceiving the customer as to its origin, but merely as a type of vermouth, distinct in flavour from the article known as French vermouth. The following are the ingredients which enter into Italian vermouth:—Sweet white wine, wormwood, helenium, calamus odoratus, centaury, holy thistle, water germander, cinnamon, angelica root, gentian, nutmeg, fresh orange sliced, and alcohol at 85°. When the process of infusion, above described, is completed, the manufacturer, or an expert connoisseur identified with his manufactory, samples the vermouth in order to find whether or not it possesses the desired taste. Should the beverage be too bitter, the fault can be remedied by adding a small quantity of wine until, little by little, the proper flavour is reached. If not sufficiently bitter, a small quantity of the solid ingredients may be again infused in the wine. Nor is it necessary that vermouth should possess great alcoholic strength to be good. Some manufacturers make vermouth which contains 17° of alcohol, while others keep their product down to 12°. The average strength is from 14° to 15°.

THE WALNUT IN FRANCE.

In France it cannot be said that the walnut tree is cultivated in the ordinary acceptation of the term. In the north-western part of France it is rarely met with, being found chiefly in the southern and southeastern part of the country, notably in the Department of Lot, Corrèze, Isère, Drome, and Dordogne. The departments of Drome and Isère produce what is known in commerce as the "Grenoble" walnut. The

nuts which grow in the Department of Lot are given the name of the department itself; those grown in Corrèze are known as "Marbots," while the "Corne" and "Brampton" walnuts come from Dordogne. But even in these regions the acreage planted in trees is very difficult, if not impossible, to determine, for the reason that they are seldom set out in orchards. On the contrary, they are found along the roadsides, or growing in small numbers in the fields. The result is that no official statistics exist, or are published regarding the acreage planted in walnut trees. Nor can the value of the land on which the trees grow be placed at any definite figure, for the reason that no land is purchased or sold especially for the growth of walnuts. When once above ground the French walnut tree grows rapidly. After a growth of two or three years it will produce a few nuts, from which the grower can determine what quality of fruit he can expect from the tree. In fifteen years the tree will give a remunerative crop. It may be said to arrive at maturity in from 50 to 60 years, when, under favourable conditions, an average tree will yield 220 pounds of nuts. A deep, well-drained soil, situated on a hill side, with a basis of lime and granite, appears to be the most suitable for the cultivation of walnuts, and with the exception of occasional trimming, the tree requires but little care. From the first year, trees are trained in the shape of a round bush, the interior of which is freed from excessive growth. Branches which appear to be developing more rapidly than the others are also trimmed or trained, in order that the tree may be well balanced. After being watched for one or two years the trees require little attention, so that little or nothing is expended in keeping them in condition. The nuts are usually gathered towards the middle of October, or sometimes at the end of September, according to the atmospheric conditions which have prevailed during the summer. Those which have fallen to the ground beneath the tree are collected in baskets, while those which still cling to the branches are beaten off with long poles. The nuts are then put in lofts or storehouses where they are allowed to dry for a period of from two to four weeks. Unless the weather is damp two weeks is usually sufficient. Before the nuts are baled for shipment they are usually exposed to sulphur fumes. This has not only the effect of cleansing the shells but acts as a preservative to the kernel. The French walnut tree, which is one of the sturdiest that grows, seldom suffers from pests or other diseases; it lives to a great age, and dies only from decay. In departments where walnuts are plentiful, a salad oil is expressed from the kernels by a crushing process. Those who have tasted this oil once, says the United States Consul at Havre, never desire to taste it again; but it is used freely by peasants who cannot afford to buy oil of a better quality made from olives. Nut oil was also formerly used by artists for the purpose of mixing colours, but of recent years it has been superseded by oil made from linseed.

General Notes.

West Indian Bulletin.—Dr. D. Morris, Commissioner of Agriculture for the West Indies, ha[s] issued at Barbados the first number of the *We[st] Indian Bulletin*, which is the journal of the Imperia[l] Agricultural Department for the West Indies. Thi[s] is a double number of 141 pages, and consists chiefl[y] of a report of the First Agricultural Conference i[n] the West Indies, which was held in January of th[e] present year, at Barbados, under the presidency o[f] Dr. Morris.

Calcium Carbide Factories in Norway.—With its many waterfalls and a plentiful supply o[f] chalkstone in some localities, Norway would appea[r] to be more favourably situated, with regard to th[e] production of calcium carbide, than countries wher[e] steam (and not water) has to be used to produce th[e] necessary electric power. H.M. Consul-General a[t] Christiania reports in a despatch, dated 8th of Jun[e] last, to the Foreign Office, that two calcium carbid[e] factories have started work in Norway. The large[r,] of 3,000 horse-power, is situated near Hafslund, th[e] smaller, of 1,500 horse-power, near Borregaard[,] facing each other on either side of the Sarpfoss wate[r]fall, above Fredrikstad. It is stated that th[e] Hafslund factory is shortly to be increased to 5,00[0] horse-power. It has been built by the Electricitä[ts] Aktiengesellschaft (formerly Schuckert and Co.[)] Nürnberg. Other factories are now in contemplatio[n.]

Workmen's Compensation. — A comparativ[e] table of the compensation allowed to the family of [a] workman overtaken by a fatal accident in Gre[at] Britain, France, Germany, Austria, Italy, an[d] Norway is published in the *Echo Des Mines* of Jun[e] 22nd. In Italy the compensation consists of a lum[p] sum equal to five times the yearly wage, and in th[e] event of there being no heirs, the indemnity is pai[d] into a common fund, which is employed for meetin[g] the insolvency of employers, subsidising the mutu[al] benefit societies that afford relief to the injure[d] during the first five days following the accident, an[d] also establishments that give medical assistance t[o] the injured, as well as for founding prizes for safet[y] appliances, while no distinction is made betwee[n] natives and foreigners. In Norway, the sum of 5[0] crowns (£2 14s. 2d.) is allowed for funeral expense[s,] and annuities are paid to the widow (or widower [if] incapable of working), and also to "ascendants,[''] equal to 20 per cent. of the annual wage, and th[e] same to orphans of both parents up to 15 years o[f] age (only 15 per cent. if they have lost but on[e] parent); but in no case must the total amount o[f] annuities exceed 50 per cent. of the wages, while n[o] annuity is given to foreign representatives no[t] residing on Norwegian soil at the time of th[e] accident. In Germany, foreigners have the sam[e] rights as natives in this respect, but if their repre[-]sentatives have left the country the Miners' Providen[t] Fund may pay a lump sum in discharge of liability.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

"OWEN JONES" PRIZE.

This competition was instituted, in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the School of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates:—

Armour, Edith O., School of Art, Battersea.—Design for printed muslin.

Kincaid, James, School of Art, Glasgow.—Designs for a hanging and a carpet rug.

Long, Thomas W., School of Art, Battersea.—Designs for printed muslin.

Marples, George, Royal College of Art, South Kensington.—Design for damask serviettes.

Simpson, Ernest H., School of Art, Leeds.—Stencilled designs for the decoration of a dining-room.

Whittaker, Bertrand, School of Art, Macclesfield.—Design for a damask table cloth.

The next award will be made in 1900, when six prizes will be offered for competition.

Proceedings of the Society.

CANTOR LECTURES.

CYCLE CONSTRUCTION AND DESIGN.

By Archibald Sharp, A.M.Inst.C.E.

Lecture I.—Delivered February 20, 1899.

A paper on "The Evolution of the Bicycle" was read in this Hall last Session by Mr. J. K. Starley. It is, therefore, unnecessary for me to say anything about the early forms of the bicycle, but I shall deal at once with the construction and design of the present-day type.

The Frame.

The frame of the bicycle is the part on which more than any other the safety and comfort of the rider depends, it may therefore suitably form the subject of the first lecture. The frame may be regarded as a structure, supported at the centres of the wheels, carrying the rider and the driving gear; while, to allow for steering, this structure is divided into two portions by a hinge joint at the steering-head. Cycles may be classified with regard to the arrangement of the steering-wheel, as shown in the accompanying Table (p. 756). Rear-steering bicycles have never been popular. Front-steering bicycles are divided into two classes—front-drivers, of which the "Bantam" bicycle, at present made by the Crypto Works Company, Limited, is the only existing example; and rear-drivers, which include the modern bicycle. Rear-drivers are further subdivided according to the driving gear adopted.

The principal dimensions of the frame on which the rider's comfort depends are (1) the wheel-base, *i.e.*, the distance between the centres of the wheels, (2) the height of the rider above the ground, (3) the position of the rider between the steering and driving wheels, (4) the slope of the steering-head, and its position relative to the centre of the steering-wheel.

Wheel-Base.—In the "Ordinary" bicycle the wheel-base was as short as possible, but it has been found that the longer the wheel-base, the greater comfort in riding over ordinary roads. At present 42 or 44 inches is about the usual wheel-base, while 48 to 50 inches is necessary for a machine with very long cranks. Whatever be the relative merits of long and short cranks, I think it probable that for the average tourist the increased wheel-base necessary for the long crank more than compensates for any

CYCLES.

- Unstable Equilibrium. ONE OR TWO WHEELED.
  - Transverse equilibrium unstable.
    - Monocycles.
      - Longitudinal equilibrium stable.
      - Longitudinal equilibrium unstable.
  - Longitudinal equilibrium stable. Transverse equilibrium unstable.
    - Bicycles.
  - Transverse equilibrium stable.
    - Dicycles.
      - Longitudinal equilibrium unstable.
      - Longitudinal equilibrium stable.
- Stable Equilibrium. TWO WHEELED.
- Stable Equilibrium. THREE OR MORE WHEELED.
  - Statically determinate frames.
    - Tricycles.
  - Statically indeterminate frames.
    - Multicycles.

BICYCLES.

- Front Steering.
  - Front Drivers.
    - Ungeared.
    - Geared.
      - Chain.
      - Toothed Wheel.
      - Clutch.
  - Rear Drivers.
    - Ungeared.
    - Geared.
      - Chain.
      - Toothed Wheel.
- Double Steering.
- Rear Steering.

slight addition to the weight of the frame. If the rider is placed exactly midway between the steering and driving wheels, he receives only half the vertical motion communicated to the wheel in passing over a stone. As regards the height of a rider above the ground, the higher the mass-centre, the easier is the steering, and less the liability to side-slip; on the other hand, the wind resistance, the most important factor at speeds over twelve miles an hour, is increased. High frames for tall riders are usually made with the same wheel-base as low frames. But for equal comfort and freedom from pitching, the high frame should be associated with a longer wheel-base. If the wheel-base were made exactly proportional to the height of frame, the angles at the corners would be the same for high or low frames, and the same set of lugs could be used.

The frame of the "Ordinary" bicycle consisted simply of a tubular backbone with rear forks at its lower end, forming practically a tubular beam. The diamond frame of the modern bicycle, on the other hand, constitutes to a great extent a braced girder. A simple beam and braced girder may fulfil exactly the same functions, but the necessary weight of the one may be very much less than that of the other. In the present lecture it is impossible for me to discuss to any extent the nature of the straining actions in beams and girders, but I must attempt to show the essential differences between the two. I have here a wooden lath (Fig. 1), about 30 inches long, which I could

FIG. 1.

easily break by supporting it at its two ends and applying my weight in the middle. By simply adding a vertical strut in the middle, and passing a piece of string between the ends of the lath and over the end of the strut, I form a simple truss which is quite strong enough to carry my weight in the middle. A beam originally straight becomes bent when supporting a transverse load, this bending is only possible if the individual fibres can vary in length. The top fibres are shortened, the bottom fibres are stretched, while at some intermediate place there is no alteration in the length of fibre. This place is the neutral surface of the beam, and if a cross section be made, the line of intersection of the neutral surface and the section plane is called the neutral axis of the section. The further a fibre is from the neutral surface, the greater evidently is its stretch or compression, and, consequently, the greater also is the intensity of the pull or push on it. The resistance to bending of a fibre in a beam is measured by the pull or push on it multiplied by its distance from the neutral surface. Hence, in a beam, to secure the greatest ecomony, *the material should be placed as far as possible from the neutral surface*. By simply turning this lath with its long faces vertical, its strength as a beam is enormously increased, while if the material be actually removed from the neighbourhood of the neutral surface and placed further away, as in the hollow rectangular beam, the strength is further increased.

Struts and Ties.—A bar subjected to a pull is called a *tie* or a *stay*, a bar subjected to a push is called a *strut*. In both struts and stays the axis of the stress coincides with that of the bar, and the acting forces are applied at the two ends. In a braced frame the object of the designer is to dispose the individual tubes so that each will be subject to either a pull or a push. The forces acting on a strut or a tie are applied at the ends, while the forces acting on a beam must be applied at three points at least. Hence, in designing a bicycle frame, if it be desired to eliminate as far as possible all bending stresses on the tubes, *none of them should be supported at three points*. I shall apply this principle in criticising some designs of frames that I shall show in the lantern presently.

Diamond Frame.—The diagram (Fig. 2, p. 758) shows the constructional evolution of the diamond frame, although the historical evolution was a much longer and more complicated process. The top figure shows a simple truss made up of two triangles, the second and third show essentially the same triangulated structure, the fourth shows the diamond frame, or, to be more correct, the pentagonal frame with sloping down-tube, in universal use at the present day. It is a maxim found in all textbooks of mechanics that the straining action on any plane section of a structure can be estimated by considering all the forces on one side of that section, hence, as the right-hand portions of Nos. 3 and 4 are identical, the

stresses on the top-tube and bottom-tube of No. 4 must be the same as in the corresponding tubes of No. 3. But these latter can only be a push and a pull respectively. It follows,

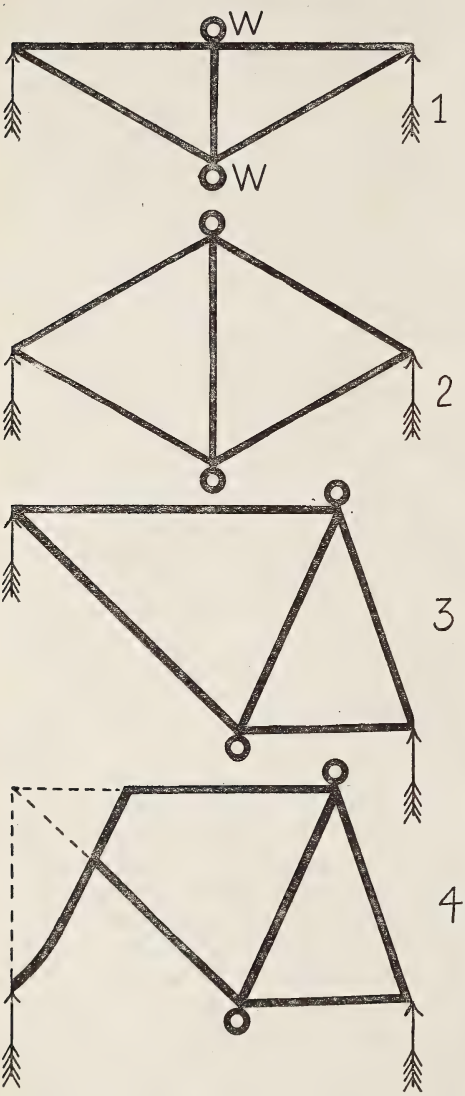


FIG. 2.

therefore, that in the diamond frame, if it be required that no bending stresses exist on the top and bottom tubes, they must, if produced, intersect at a point vertically above the front-wheel centre (Fig. 3). If these conditions be not attended to, there will be bending stresses on them transmitted by the lugs. I have here a model which illustrates this fact. This model of a diamond frame is made with pin-joints which can be screwed up tight so as to offer a considerable resistance to distortion at the lugs, or which may be left quite loose so that the open quadrilateral of the frame is free to take up any position under the action of the forces. If the steering-head be too long, the frame collapses in one direction (Fig. 4); if the steering-head be too short, the frame collapses in the other direction (Fig. 5). The small brass models, lent by Mr. Dawson, M.Inst.C.E., and designer of the Amulet bicycle frame, shows the same phenomena. These models are all pin-jointed so that each member can act only as a strut or a tie, but cannot resist bending. The incompletely triangulated frames can therefore all be distorted. But, as regards lateral bending, they are all more nearly on an equal footing.

FIG. 3.

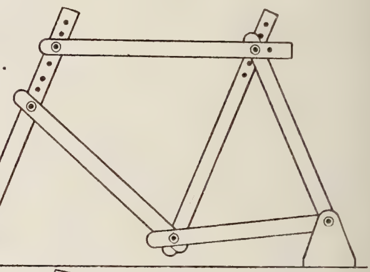


FIG. 4.

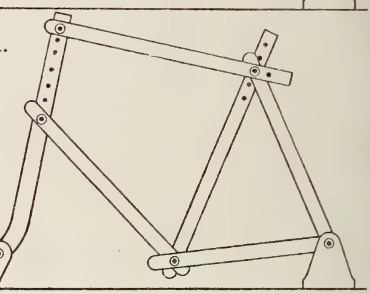
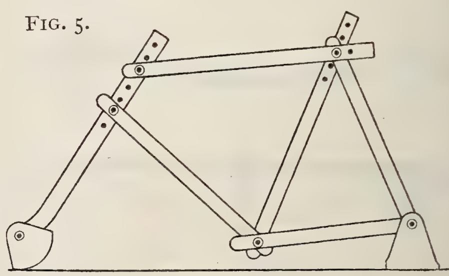


FIG. 5.



If a diagonal be inserted in the frame from the top of the steering-head to the crank-bracket, the frame is triangulated, and, assuming there are no bending stresses at the lugs, it is easy to calculate the stress on each tube. The stress-diagram for such a frame, the weight of the rider being assumed 150 lbs., of which 30 lbs. is applied at the crank-bracket, shows that the greatest stress is along the seat-struts, on which the thrust is in

this particular example 117 lbs. If the driving gear and the pedal pressure could be applied in the middle of the frame, a sectional area of less than 1-100th square inch would be amply sufficient to give the necessary strength for the seat-struts, and the total weight of a bicycle frame might be well under 12 lbs. But, as will be seen presently, the lateral stresses due to the pedal pressure and the pull of the chain are very much greater than those due to weight. It is comforting, therefore, to any rider whose machine happens to run away downhill, that the frame has a very large margin of strength for resisting vertical stresses, with the exception perhaps of the steering-post. By sitting far back on the saddle, the stress on the steering-post is diminished. The Raleigh X frame bicycle has its frame completely triangulated, and it is perceptibly more rigid than the usual type.

Any triangulated structure may be regarded as a whole as a beam, and this point of view is useful sometimes in dealing with bicycle frames. The bending-moment on any section depends on the wheel-base, the position and magnitude of the load, and in no way on the shape of the frame. Similarly, in a bridge-girder of a given span to carry a certain load, the straining action on any vertical section is measured by the bending-moment on that section, and is quite independent of the type of girder, whether plate, lattice, or bowstring. We therefore see that, taking a top-tube of a certain size, the vertical strength of the frame as a whole is proportional to its depth; or, conversely, for a given load the stresses on the tubes are inversely proportional to the depth of the frame.

In the frame of a lady's bicycle, with two straight tubes to the steering-head (Fig. 6),

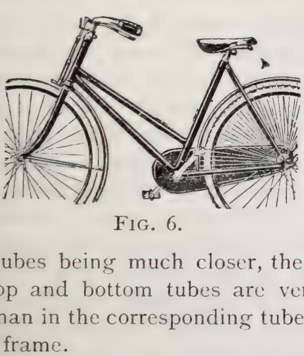


FIG. 6.

the two tubes being much closer, the stresses on the top and bottom tubes are very much greater than in the corresponding tubes of the diamond frame.

In the Crypto front-driver (Fig. 7), the crank-axle is concentric with the driving-wheel hub, and the rider is more nearly midway between the wheels. The wheel-base is less, consequently the bending-moment on the frame is less.

FIG. 7.

In a tandem bicycle, the weight carried is double, and the wheel-base is greater than in a single, the thrust on the top tubes is about two-and-a-half and three times that on the top-tube of the single machine. The thrusts on the diagonal and on the front down-tube are respectively about three-and-a-half and six-and-a-half times that on the down-tube of the single machine, while the pull on the rear down-tube is about four times the thrust on the down-tube of the single machine.

Driving Pressure—Chain-Struts.—From the fact that the centre of the pedal is a considerable distance from the middle plane of the frame, and from the fact that the transverse dimensions of the frame are reduced as much as possible in order to keep down the tread, the transverse stresses on the frame when pedalling hard are very much greater than those due to mere weight on the saddle. In fact, it is these transverse stresses that practically determine the size of the tubes used in the frame. In the same way, the pull of the chain tends to bend the lower back-forks sideways, and they have to be designed to the best advantage to resist this bending (Fig. 8). Round tubes (*a*) and **D** tubes (*b*) are most commonly used. In order to keep the tread as narrow as possible, the space between the tyre and the side of the crank must be small, an oval tube with its long axis in the plane of bending (*c*) cannot therefore be used. Twin tubes (*d*) were first used, I believe, in Mr. C. W. Brown's dropped frame, then by Messrs. Humber and Co., and are now used by a great number of makers, the frame of the Centaur cycle being a good example. A careful investigation will reveal the fact that twin tubes are just equivalent to a single tube of weight equal to that of the twin tubes. Since as much

material as possible should be disposed at the greatest distance from the neutral axis, greater strength is obtained by taking an oval tube (*e*) of the same weight as the round tube, but of much greater perimeter; a still better arrangement is to use a rectangular tube (*f*), as in the Referee bicycle. I have suggested a further development in this direction by having a brazed rectangular tube made from two pieces of thin steel plate of high strength (*g*), in which

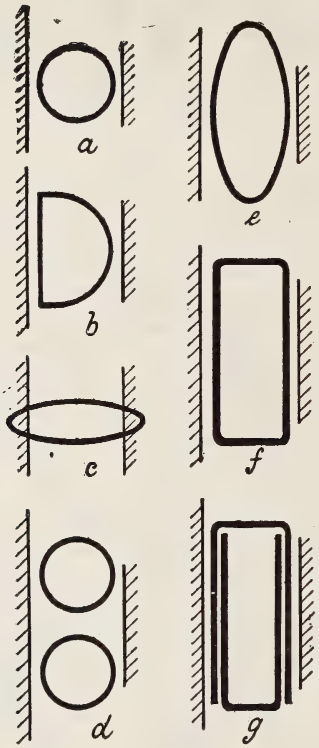


FIG. 8.

the thickness of the flanges is twice that of the webs. The fastening of the chain-struts to the crank-bracket and the bridge-piece should be as rigid as possible, in order to confine the unavoidable comparative flexibility to the portions at the sides of the wheel. The B.S.A. fittings, with two tubes 1 inch diameter from bracket to bridge-piece, are well designed in this respect.

Down-Tube.—For similar reasons the frame would be much stiffer under the vertical pressure on the pedals if the down-tube were made in duplicate, one tube going to each end of the crank-bracket. This design was fairly common some years ago, and was known as the double diamond frame, the bottom-tube from the crank-bracket to the bottom of the steering-head being also in duplicate.

The diagram (Fig. 9) shows sketches of two machine frames, in each of which a straining action is produced by screwing the central bolt. If the bolt be in compression, the two ends of the frame tend to separate. In the right-hand sketch, which represents diagrammatically one form of testing machine, this tendency is directly resisted by the pull on the two tie bolts. In the left-hand sketch, which represents diagrammatically a punching or rivetting machine, the straining action due to the central bolt has to be transmitted in a roundabout way, and bending stresses of considerable magnitude are induced. In the first machine the lines of the frame follow closely the line of the applied stress; in the second machine this is not possible, and the frame is proportionately much heavier. Similarly, in making the crank-bracket of a bicycle stiff under the action of the pedal pressure, the line

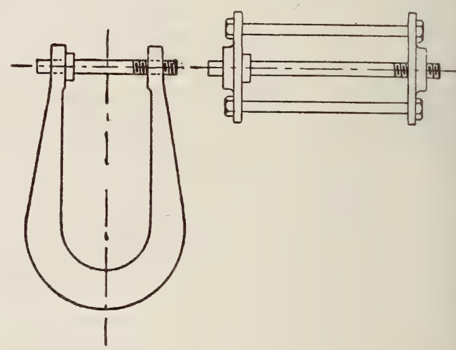


FIG. 9.

of thrust of the leg may be taken as between the saddle and the pedal, and the greatest economy of material will be obtained when the lines of the frame follow this as closely as possible.

If we could conceive the back wheel to be taken out, and a horizontal diagonal from one end of the crank-bracket to the opposite end of the hub-spindle be inserted, the rear-frame so obtained would be a perfectly braced structure in three dimensions, and would be as stiff as the width of tread would allow.

Frame of Chainless.—The stresses on the lower back-fork, due to the driving effort on a bevel-gear bicycle, are of quite a different nature. Fig. 10 shows diagrammatically the forces on the gear and lower back-fork when a driving effort is applied. The upper diagram shows the pressures between the toothed-wheels and on the bearings, the lower diagram shows the direction of the pressures on the frame-tube supporting the intermediate

axle, due to the driving effort. These four forces constitute an upward bending action in a vertical plane. The maximum bending-moment is equal to the mutual pressure on the front pair of wheels multiplied by the radius of the large wheel. The twisting-moment on the rotating shaft is the product of the same pressure into the radius of the small bevel-wheel. Hence the straining action on the frame-tube is much more severe than that on the rotating shaft. The greatest twisting-moment a tube of circular section may be safely subjected to is twice the bending-moment it may safely stand; in other words, a circular tube is twice as strong in torsion as in bending. Therefore, it seems more in accordance with the nature of things to have the frame-tube outside the rotating shaft, as is done in

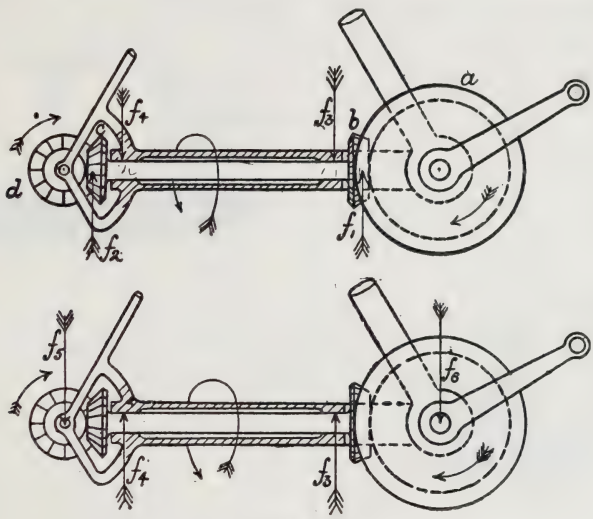


FIG. 10.

the Columbia and Sterling bicycles. In the Acaténe and the Quadrant cross-roller bicycles, the frame-tube is inside the rotating shaft.

Frame of Lady's Bicycle.—The frame, with two straight tubes converging to a point vertically over the centre of the front wheel, gives the best arrangement as regards a vertical load. The down-tube is subjected to bending by the thrust of the top-tube, but if made stout enough to resist the lateral bending due to the pedal pressure, it will be stout enough to bear the thrust of the top-tube. To make the frame a perfectly braced structure, a pair of tubes should be taken to the driving-wheel spindle, the introduction of this pair of tubes would also strengthen the frame laterally against the pull of the chain. The frame of the Amulet bicycle (Fig. 11) answers almost exactly to this description. A frame with diverging tubes is weaker immediately above the crank-bracket, the


FIG. 11.

effective depth of the frame at this point being reduced. The long unsupported head of the straight tube frame is subjected to no stress due to the weight of the rider, but if the handles be pulled backwards or pushed forwards, stresses are introduced. The Osmond frame, with a small curved piece joining the top tube


FIG. 12.

to the top of the steering-head, is an improvement in this respect. The Raleigh frame (Fig. 12) has a further advantage, that the tube from the top of the steering-head to the

crank-axle, besides supporting the former, stiffens the latter against lateral bending. The Amulet frame has all these advantages, and the further important one that the extra pair of back-forks, a short distance above the crank-axle, makes it stiff under the pull of the chain. The popular type of frame (Fig. 13),

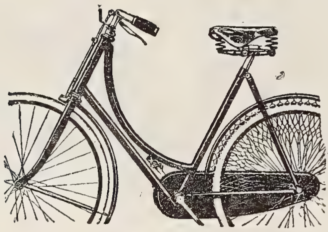


FIG. 13.

with one straight and one curved tube, is not vertically so rigid as the frames already described, as both tubes may be subjected to bending, being not sufficiently connected together. If great clearance for the dress be desired, as well as strength and rigidity, Burford's web frame, consisting of two tubes united by a central web, is to be recommended.

Vertical strength has been obtained by dropping the frame below the crank-axle, the best known example being Mr. C. W. Brown's frame (Fig. 14).

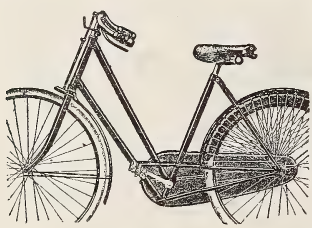


FIG. 14.

Tandem Frames.—The best arrangement as regards vertical strength is shown by Fig. 15, giving practically a triangulated

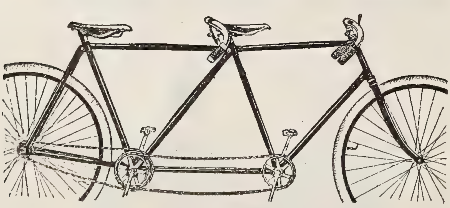


FIG. 15.

frame. Sometimes a second top-tube is added, but I cannot see that this increases the vertical strength.

When a tandem is required for a lady and gentleman, the lady may occupy either the front or the back seat; Fig. 16 shows a lady-front tandem. This frame leaves something to be desired as regards vertical strength. Brown's open-front tandem frame is much better in this respect, while the duplex chain-

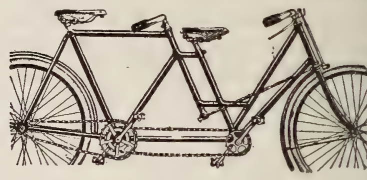


FIG. 16.

struts make it stiff laterally. The Mohawk open-back tandem frame is completely triangulated, and strong vertically. It would perhaps be slightly improved in resisting torsional strains by making the diagonal run from the front crank-bracket to the top of the steering-head. The Raleigh and Referee tandem frames (Fig. 17) are designed for a

FIG. 17.

lady to occupy the back seat, while the frame being slightly dropped in front allows the front rider greater facilities for dismounting.

There is no difficulty in making tandem and multiplet frames as stiff vertically as required, but the longer the frame the more whippy it becomes unless special precautions be taken to strengthen it against lateral bending and twisting. A multiplet frame may be roughly compared to a thin sheet of steel which is very strong vertically but quite flexible laterally. No arrangement of bracing in the vertical plane can strengthen the frame laterally. The necessity of keeping the tread narrow practically precludes lateral bracing, and the lateral rigidity must be obtained by the resistance of the tubes to bending. If the two riders do not nick together in pedalling, a considerable torsional strain is put on the frame. This can best be resisted by a single tube of large diameter.

Front-Frame.—The front-frame consists of the fork-sides, fork-crown, steering-tube, and handle-bar. The steering-post and fork-sides form practically a beam on which the greatest straining action occurs near the lower end of the steering-tube. Practically

the weakest point of present day bicycles under a vertical load is the bottom of the steering-head. It is very important that this should be sufficiently strong, since the greatest stress at this point will occur when running down-hill at a high speed over an uneven road, under which conditions weakness in the steering-tube might be fatal. The greatest stress on the other portions of the frame probably occurs when a heavy driving effort is being exerted, as when going uphill. Under these conditions, the speed is usually slow, and even though the frame should prove to be weak, no serious accident is likely to occur. If the rear-frame be strong enough laterally to resist the driving effort it will be quite strong enough to resist the vertical stresses when running downhill at a high speed. A braced-front frame is probably the strongest and stiffest structure, but may be objected to on the score of appearance. The Referee triple-head is a very well-known contrivance for adding to the strength of the front-frame.

The crown serves to unite the top of the fork-sides and the bottom of the steering-tube. The most commonly used is the plate-crown, which has for one of its recommendations that its design is such that even with imperfect workmanship in brazing the fork-sides it may stand quite satisfactorily. In the B.S.A. crown (Fig. 18), an inside lug projects from the under

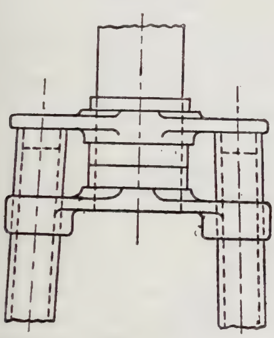


Fig. 18.

surface of the top-plate, and fits into the end of the fork-side, so that the parts will hold together in position without brazing. A triple-plate crown is sometimes used in tandems and multiplets, the designers evidently thinking that if two plates are good, three plates are much better, but since the crown is subjected to bending and torsion, the stresses can be best resisted by having the material as far apart as possible. No bridge builder would ever dream of putting a third flange in a plate-girder midway between the top and bottom flanges.

The arched fork-crown (Fig. 19) is much used by American makers, it is neater in

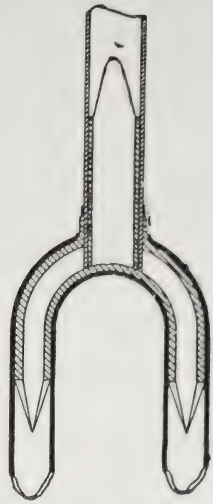


Fig. 19.

external appearance, and is easier to keep clean. From the disposition of the material it must be slighly heavier, other things being equal, than the plate-crown.

Spring Frames.—A spring frame is intended to reduce vibration and give the rider greater comfort when passing over a rough road, as compared with a rigid frame under the same conditions. Most spring frames have specially made springs inserted at various places. The Triumph Cycle Company, Limited, in their "natural spring frames," make the various frame-tubes curved so that they may yield more than a straight-tubed frame carrying the same load. A spring frame has to absorb a certain quantity of energy or work, which it again restores.

The extension of a bar of unit length and section is proportional to the stress applied within certain limits. But the work done in extending a bar of unit length and sectional area is half the product of the greatest stress and the extension produced by that stress. Therefore the work or energy that can be absorbed by a bar of unit volume without permanently altering its shape is proportional to the square of its elastic strength. In steel of a quality like that of a weldless tube, the elastic limit may be about 12 tons per square inch, in a wire spring of tempered steel the elastic limit may be 100 tons per square inch. Taking the elastic limit of the

material in a properly constructed spring at 6 times that of a weldless steel tube, the weight of a natural spring frame would be 36 times that of specially designed springs capable of absorbing the same shock.

This figure requires a slight modification, as the specific extension of tempered steel is somewhat lest than that of mild steel, the ratio being, roughly, 5 to 6; making the weight of the natural spring frame 30 times that of the properly constructed special spring frame for the same shock. Thus, the natural spring frame, unless very heavy, cannot absorb as much shock as one with special springs; on the other hand, the complexity of the frame with special springs has hitherto prevented it from becoming popular.

Miscellaneous.

STANDARD TIME IN INDIA.

The suggestions of Mr. Oldham, the superintendent of the Geological Survey of India, respecting a standard time for India, in a paper printed by the Asiatic Society of Bengal, are quoted in *The Times*.

Mr. Oldham describes the present system in that country, by which every place keeps its own time, as a barbarous arrangement, unworthy of a country pretending to civilisation. A traveller going from one town to keep an appointment in another must find out how many minutes there is between the times of the two. To some extent a standard time is used, for the railways adopt Madras mean time all over India, and the telegraph department does the same, but the official telegraph guide contains a table of 44 pages, giving the difference between local and standard times. The adoption of a single standard time for India would cause inconvenience because of the extent of the empire from east to west; in some places the difference would exceed an hour. This difficulty, Mr. Oldham suggests, would be met by adopting the system in use in Europe and North America of hour zones, by which the region is divided into belts running north and south, each 15° of longitude in width. Over each belt the same time is used, while in belts to the east and west a change of an hour forwards or backwards is made. In India the lines could follow the boundaries of the chief administrative divisions, as is done in the United States, Canada, and Russia. After discussing various suggested standards of time, Mr. Oldham recommends the adoption of the hour zone system, using Greenwich as the starting-point. This would give only two different times in India, an eastern time, exactly six hours later than Greenwich time, in use in Bengal, Assam, and Burma, and a western time, exactly five hours later than Greenwich, in use in the rest of India. The traveller in either group of presidencies or provinces would find the same time in use everywhere, and when he crossed the boundary he would know that the time was an even hour earlier or later according as he was travelling westward or eastward. In practice, in Calcutta all watches would have to be put back six minutes, but on the other hand the railway clocks and those in the rest of the town would not show different times. "I have myself," says Mr. Oldham, "recently had to deal with a mass of time records referring to the earthquake of 1897, and found that a large number had to be rejected because it was impossible to ascertain what standard of time had been used, while in many others it was only after a large mass of calculations had been gone through that the relation of observations from different places to each other could be determined." The steps necessary to initiate the change are stated to be very simple. The first would be to discontinue the 44 pages of variations in the telegraph guide, and when local time was no longer obtainable at the telegraph offices, standard time would come into use. In the local observatories in the presidency towns the time signals should be converted into Greenwich time; and in all public offices standard time should be used. "If this were done, the experience of other countries has shown that the general public would soon come to adopt the standard time, and having once appreciated its advantages, would soon wonder how they had so long endured the old system."

ARTIFICIAL PRODUCTION OF INDIA-RUBBER.

The *Kew Gardens Bulletin* contains an article on Dr. Tilden's Artificial Production of India-rubber, and quotes from his paper on the Spontaneous Conversion of Isoprene into Caoutchouc, read before the Birmingham Philosophical Society.

India-rubber, or caoutchouc, is chemically a hydrocarbon. But what is called its molecular constitution is unknown. All that has been ascertained is that when decomposed by heat (distillation in closed vessels) it is broken up into simpler hydrocarbons, amongst which is isoprene. Isoprene is a hydrocarbon which was discovered by Greville Williams many years ago among the products of the destructive distillation of india-rubber. Later, in 1884*, it was observed by Dr. Tilden among the more volatile compounds obtained by the action of a moderate heat upon oil of turpentine and other terpenes. It is a very volatile liquid, boiling at about 36°. Its molecular formula is C_5H_8, and it forms a tetrabromide, $C_5H_8Br_4$, but no metallic derivatives like the two homologues of acetylene.

Bouchardat† observed that when isoprene is heated to a temperature near 300°, it gradually polymerises

* "Trans. Chem. Soc.," vol. 45, p. 410.

† "Compt. rend.," vol. 87, p. 654, and vol. 89, pp. 361 and 1117.

into a terpene, which he called diisoprene, but which is now called dipentene. This compound boils at 176°. A quantity of colophene, similar to that which is produced by the action of heat upon turpentine, is formed at the same time. When isoprene is brought into contact with strong acids, aqueous hydrochloric acid for example, a small portion of it is converted into a tough elastic solid, which has been examined by G. Bouchardat and by Dr. Tilden. It appears to be true india-rubber.

Specimens of isoprene were made from several terpenes in the course of Dr. Tilden's work on those compounds, and some of them have been preserved. He was surprised at finding the contents of the bottles containing isoprene from turpentine entirely changed in appearance. In place of a limpid colourless liquid, the bottle contained a dense syrup in which was floating several large masses of a solid of a yellowish colour. Upon examination, this turned out to be india-rubber.

The artificial india-rubber, like natural rubber, appears to consist of two substances, one of which is more soluble in benzene or carbon bisulphide than the other.

A solution of the artificial rubber in benzene leaves on evaporation a residue which agrees in all characters with a similar preparation from Para-rubber.

The artificial rubber unites with sulphur in the same way as ordinary rubber, forming a tough elastic compound.

The constitutional formula of isoprene is now known to be :—

Methyl-crotonylene, $CH_2 = CCH_3 - CH = CH_2$.

In a recent letter, Professor Tilden states:—"As you may imagine, I have tried everything I can think of as likely to promote this change, but without success. The polymerisation proceeds *very* slowly, occupying, according to my experience, several years, and all attempts to hurry it result in the production not of rubber but of 'colophene,' a thick sticky oil quite useless for all the purposes to which rubber is applied."

VICTORIA AND ALBERT MUSEUM, SOUTH KENSINGTON.

Sir T. D. Gibson Carmichael, Bart., M.P., has lent his very valuable collection of goldsmiths' work and jewellery for exhibition, and the case containing it is situated in the South Court. The most important work of art in this collection is an exquisite gold shrine, probably of Flemish or Burgundian work of the 15th century. It encloses an enamelled group, consisting of a half-length figure of Our Lord crowned with thorns, upheld by an angel with outspread wings. The two doors of the shrine are decorated on the inside with the Virgin and St. John the Evangelist in translucent enamel, and on the outside with representations of St. John the Baptist and St. Catherine of Alexandria. On the top is a group of the Coronation of the Virgin. The back is engraved in dotted work with the Death and Assumption of the Virgin. The little cross-shaped receptacle at the top was evidently intended to contain a piece of the true cross. When not in use, this relic was taken out and placed in a compartment constructed expressly for it behind the door in the back, on which appears the Vernacle.

Mr. George Salting has also lent some additions to his collection which will be found in the South Court. The most important, on account of the rarity of its shape, is the fine ewer of enamelled earthenware decorated with ruby and mother-of pearl lustre, at Gubbio, at the beginning of the 16th century. In front is a shield of arms with helmet, crest, and mantling, the whole being surrounded by a wreath. In his case of Limoges enamels is to be seen another recent acquisition—an enamelled plaque representing Our Lord in the Garden of Gethsemane, by Jean Penicaud I., of Limoges. In one of the arcades are two walnut panels of the early part of the 16th century, carved with angels beneath Gothic niches. The angels have a very distinct German character about them, but the panels are stated to come from the district of Bresse, near Lyons. Mr. Salting has also acquired and lent the carpet which was the property of the late Lord Leighton. At the top is a cheetah hunting a deer, and below is a lion devouring his prey, whilst at the bottom is a curious monster, somewhat resembling the Chinese lion, chasing a deer of equally strange form. The whole is surrounded by a conventional floral border.

In the Tapestry Court may be seen a valuable carpet, lent to the Museum for a short time by the Girdlers' Company. In the centre are the arms of the company, and on either side are two panels, one with an eagle and one containing devices, the meaning of which are at present unknown. This carpet is not only of a beautiful and instructive type, but is of considerable value to the student of the history of carpets, as it is known that this carpet was ordered to be made for the company in the early part of the 17th century.

The Museum itself has gradually acquired a representative series of costumes of the Georgian period. A recent addition to the collection of ladies' dresses shows a somewhat unusual combination of weaving, painting, and embroidery. The dress is of damask brocade, with sprays of flowers carefully painted by hand, and small leaves embroidered in blue silk. It dates from near the middle of the 18th century. An interesting coat and waistcoat have lately been presented to the Museum by Mr. Frederick Rathbone. They are of silk with a small diaper patern in uncut velvet pile. The buttons are of Wedgwood's jasper ware, with classical figures and contemporary portraits in white on a blue ground. The shape of the coat and waistcoat show them to date from the later years of the 18th century. These costumes may be seen in cases in one of the arcades of the South Court.

Obituary.

Sir Edward Frankland, K.C.B., F.R.S.—Sir E. Frankland, the distinguished chemist, who died in Norway on Wednesday, 9th inst., was a member of the Society of Arts since 1877, and held a seat on the Council in 1881 and 1882. He presided on several occasions at the evening meetings, and frequently joined in the discussions on Water Supply and River Pollution. He also contributed a paper to the Water Supply Congress held by the Society in May, 1878. Frankland was born at Churchtown, near Lancaster, in 1825, and was educated at Lancaster Grammar School. He afterwards studied chemistry at the Museum of Practical Geology, and in the laboratories of Liebig and Bunsen at Giessen and Marburg. He was appointed Professor of Chemistry in Owens College, Manchester, in 1851, in St. Bartholomew's Hospital in 1857, in the Royal Institution in 1863, in the Royal College of Chemistry in 1865, and in the Normal School of Science (South Kensington) in 1881. When he succeeded Dr. Hofmann in 1865, as Professor at the College of Chemistry, he undertook to continue the monthly analysis of the water supplied to the metropolis, which Hofmann had begun a few months before for the Registrar-General's reports, and Frankland continued these analyses from that date. In 1868, he was appointed a member of the second Royal Commission on the Pollution of Rivers, when the Government supplied him with a fully-equipped laboratory to enable him to carry out the necessary inquiries. In August, 1859, he spent a night on the summit of Mont Blanc in company with Dr. Tyndall, when was commenced his series of experiments on the source of light in luminous flames. About 1866, he commenced his researches on the source of muscular power, in connection with his ascent of the Faulhorn in company with Fick and Wislicenus. He was elected a Fellow of the Royal Society in 1853, and in 1857 he received its royal medal for his "Researches on the Isolation of the Radicals of Organic Compounds." In 1894 the Copley medal was presented to him. He was foreign secretary of the Royal Society at the time of his death. Frankland was a member of several foreign academies. He was elected, in 1866, a corresponding member of the French Academy of Sciences, and subsequently he became a foreign member of the Academies of Berlin, Munich, Upsala, &c. He was president of the Chemical Society in 1871, and the first president of the Society of Chemical Industry in 1877. The University of Oxford gave him the degree of D.C.L. in 1877, and Edinburgh that of LL.D. in 1884. The honour of K.C.B. was bestowed upon him in 1897.

General Notes.

Royal Academy.—It has been decided by th President and Council of the Royal Academy tha the next winter exhibition shall consist exclusively o the works of Van Dyck.

Russian Calendar.—The Russian Government after many years' discussion, has determined to abandoı the old styie or Julian calendar, which is twelve days behind the now univessal system of the Gregoriaı cycle, and which has been a source of annoyance tc Russians doing business with other countries whc were compelled to use both dates, as well as tc foreigners trading with Russia. The St. Petersburg Astronomical Society has taken the matter in hand, and with the co-operation of the ministers will appoint a commission to be composed of sixteen persons, nine of whom are to be members of the Astronomical Society who will arrange the details. It is expected that the new style calendar will come into effect in 1901.

Millais Memorial.—It was decided at a meeting held at Marlborough House, under the presidency of H.R.H. the Prince of Wales, that a bronze statue of the late Sir John Everett Millais, Bart., P.R.A., should be erected in front of the Tate Gallery, Millbank, and at a meeting of the Sub-Committee, held on the 18th July, 1899, Sir Edward Poynter reported that Mr. Thomas Brock, R.A., had consented to execute the statue and pedestal, and promised to prepare a sketch for the statue without delay. It was hoped that the statue might have been placed on the main floor of St. Paul's Cathedral, but the Dean was unable to give his consent to this as every available space was already occupied. It is hoped that a mural tablet to Sir John's memory may be erected in the Cathedral. The subscriptions amount in all to £2,100.

Iron in America.—The production of pig iron in the United States in the first half of 1899 was 6,289,167 gross tons, against 5,869,703 tons in the first half of 1898, and 5,904,231 tons in the second half. The production of Bessemer pig iron in the first half of 1899 was 3,788,907 gross tons, against 3,703,584 tons in the first half of 1898, and 3,633,800 tons in the second half. The production of basic pig iron in the first half of 1809, all made with coke or mixed anthracite coal and coke as fuel, was 465,657 gross tons, against 337,485 tons in the first half of 1898, and 447,959 tons in the second half. The production of spiegeleisen and ferro-manganese in the first half of 1899 was 104,496 gross tons, against 109,641 tons in the first half of 1898, and 104,128 tons in the second half. The whole number of furnances in blast in the United States on June 30th, 1899, was 240 against 202 on December 31st, 1898. The number out of blast on June 30th was 175, of which several have since been blown in and others are preparing to blow in.—*Engineer.*

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FRIDAY, AUGUST 25, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

CYCLE CONSTRUCTION AND DESIGN.

By Archibald Sharp, A.M.Inst.C.E.

Lecture II.—Delivered February 27, 1899.

Ball Bearings.

The earliest bearings used in cycle construction were of the plain cylindrical journal type. With the now almost universal adoption of ball bearings for cycles, the general impression amongst cyclists is that the frictional resistance of the latter is very much less than that of the former. As a matter of fact, if the cylindrical journal bearing can be kept efficiently lubricated there is little to choose between it and a ball bearing when each is carrying a fairly heavy load. It is the question of lubrication that separates the two types and makes the ball bearing far superior for cycles. A cylindrical journal bearing must be lubricated continuously if the best results are to be obtained from it, whereas a ball bearing will run satisfactorily for a long time without any oil supply. At the present day the plain cylindrical bearing is used for the crank-axle in the Collier two-speed gear, and for the spindles of the intermediate pinions of the Crypto front-driving gear. In both cases provision is made for efficient lubrication, and the rider of either would never suspect from his actual experience that he had such an old-fashioned contrivance on his machine.

Adjustable Bearings.—The adjustment after wear of a cylindrical bearing is a matter for the mechanic; if the bearing surfaces be made conical a simple screw adjustment can be used to take up the wear, A conical bearing was much used for the back hub of the Ordinary bicycle.

Ball Bearings.—Fig. 1 shows a diagrammatic section of a ball bearing with conical adjustment. Two rolls of balls, B, each run between a pair of hardened steel ball paths, one fixed to the spindle, and one to the barrel. One of the cones is screwed up hard against a shoulder on the spindle, while the other is screwed until both rows of balls are lightly pressed between their paths, and no perceptible shake is left. The adjusting cone is locked in position by the lock-nut N.

There are three kinds of motion at the point or surface of contact of two bodies having relative motion, viz., rubbing, rolling, and spinning. In ball-bearings these three motions exist simultaneously, although it is a popular belief that only rolling motion exists. Two adjacent balls rub on each other; but the mutua pressure between the balls is very little. Fig. 2 is intended to show the nature of the rolling and spinning motions. The motion of a ball relative to its path may be most conveniently studied by imparting to the

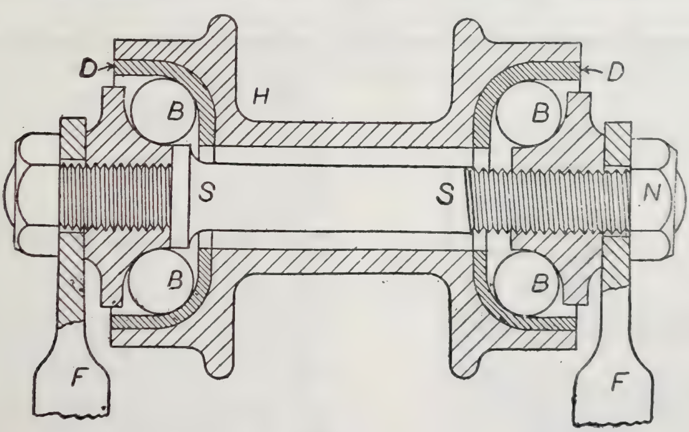


Fig. 1.

whole system a rotation about the axes of the bearing sufficient to bring the centre *c* of the ball to rest. The ball-paths C and D will then be rotating in opposite directions. If the bearing is of a two-point contact type, the pressures f_1 and f_2 on the balls (Fig. 2) must be

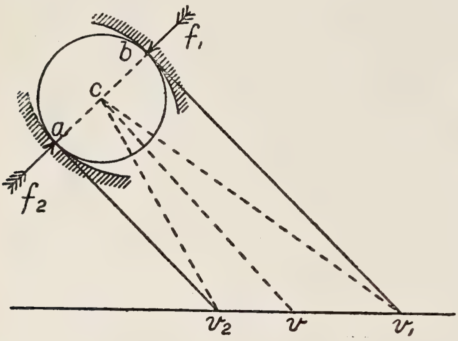


FIG 2.

equal and opposite, and therefore the points of contact *a* and *b* of the ball with its paths must be at the ends of a diameter. From *a* let a tangent av_2 be drawn to the common surfaces in contact; then if pure rolling motion exists at *a*, the parts of the ball and of the ball-path which actually roll on each other may be considered to be small portions of a pair of cones having a common vertex, v_2; the ball B must therefore be rotating about the axis cv_1. Consider the motion of the ball on the outer path D, a similar argument will show that if the relative motion at *b* be pure rolling the ball must be rotating about an axis cv_1. But the ball cannot be rotating at the same instant about two different axes. The probability is that it does rotate about some axis cv, in which case slight spinning motions exist at *a* and *b* in addition to the rolling motion.

Two, Three, and Four Point Contacts.—In Fig. 1 each ball has two points of contact with

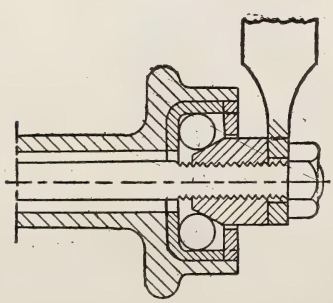


FIG. 3.

its paths. Fig 3 shows a three-point, Fig. 4 a four-point contact bearing. The three-point contact bearing has a considerably greater amount of spinning friction. The instantaneous axis of relative motion must itself pass through

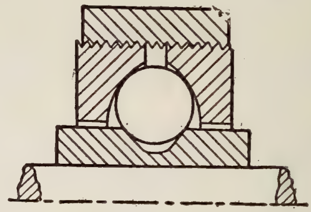


FIG. 4.

the two points of contact of the outer path. But if only a pure rolling motion existed at each of these points the instantaneous axis must lie in the surface of the ball-path. There must, therefore, be a considerable spinning motion at each point, so as to bring the resultant motion to take place round the aforementioned axis.

One or two important points of comparison may be made between the two types of bearing. Fig. 5 shows three sections of a two-point bear-

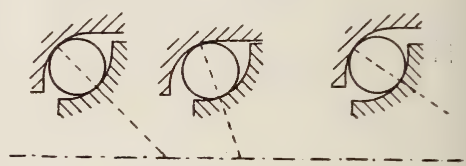


FIG. 5.

ing. The first section shows the line of contact making an angle of 45 deg. with the axis. The second section shows the inner path of exactly the same dimensions as in the first case, the outer path of exactly the same outline, but with its diameter a little less; the effect is to bring the line of contact nearly perpendicular to the axis. The third section shows the outer ball-path a little larger in diameter than in the first; the effect is to bring the line of contact more nearly parallel to the axis. In the second case there is little or no resistance to end thrust, and the balls may actually jamb between the ball-paths, developing pressure sufficient to break one or other. In the third case the wedging action of the bearing is greatly intensified, and the total pressure on the balls may be three or four times that due to the transverse load on the bearing. In a three-point bearing, the cone being straight-sided, if any deviations be made from the normal size of the cone or cup, no alteration is made in the direction of the line of contact, and no evil effects arise.

Nomenclature and Classification.—The inner ball-path is usually termed a *cone*, the outer ball-path a *cup* or a *disc*. The inner portion of the bearing I shall call the *spindle*, and the outer portion, the *barrel*. In wheel hubs, the barrel rotates, in pedals and crank-brackets, the spindle rotates. From Figure 1 it is easily seen that the adjustment of the bearing can be obtained by moving one of the four ball-paths; we, therefore, have two types of adjustment, *cone-adjusting* and *cup-adjusting* bearings.

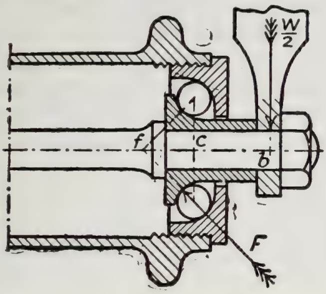


Fig. 6.

Figures 6 and 7 show two types of bearing; in Fig. 6 the cups face outwards; in Fig. 7,

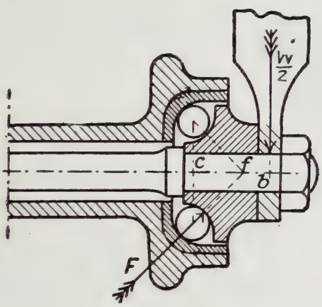


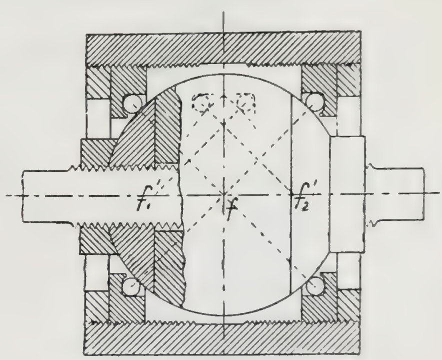
Fig. 7.

they face inwards. Some important properties of ball-bearings, which I shall refer to presently, depend on the direction in which the cups face; I have, therefore, called them "outward-cups" and "inward-cups" bearings respectively.

Pressure on Bearings.—It is well known that owing to the slope of the ball-paths, there is a kind of wedging action in ball-bearings, so that the total pressure on the balls is greater than the external load. Figs. 6 and 7 show the direction of the pressures. In a pedal or in a front-wheel hub where the load comes exactly at the middle of the length of the bearing the pressures on the balls will be the same for outward-cups and inward-cups bearings, provided the slope of the paths be the same in both. The point f where the line of contact of the balls cuts the axis, may be called the "point of virtual support" of the bearing, and the distance between these two points for the two ball rows may be called the "virtual length" of the bearing. It will be noticed from the diagram that provided the actual distance between the ball rows be the same in both cases, the outward-cups bearing has a much greater virtual length than the inward-cups bearing. The model illustrates this point very well. I have here what is practically a hub with very large ball-races, at present it is arranged as an inward-cups bearing (Fig. 8), and the two points f, for each row of balls coincide at the middle of the bearing, the virtual length is therefore zero, and the bearing as you see, has no lateral stability; it constitutes, in fact, a universal joint. Its lateral stability is increased by either moving the ball-races closer together or further apart.

Mr. Ackermann will now remove the central distance piece, and bring the ball-races as close together as the model permits. The pressure lines from the two rows of balls now cross, as indicated by the dotted lines (Fig. 8);

Fig. 8.



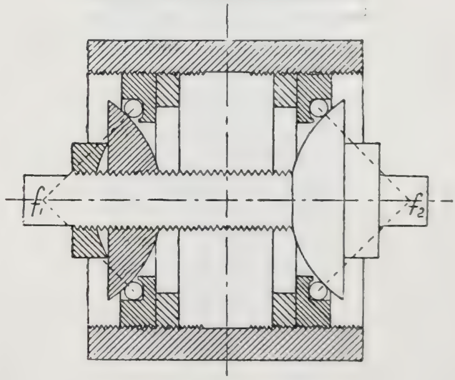


Fig. 9.

and, as you see, the bearing has now a fair amount of lateral stability. The model may

now be arranged as an outward-cups bearing, and keeping the same distance between the ball-races, as in the first experiment, the virtual length is greatly increased ($f_1 f_2$ Fig. 9); and, as you see, the bearing is very stable laterally.

Pressure on Crank-axle Bearings.—In a bearing where the pressure is applied outside the ball-races, as in the case of a crank-axle, the actual pressures on the rows of balls is very much less with outward-cups than with inward-cups. At present, it is almost the universal practice of English makers to have the crank-bracket bearing with inward-cups, but many American makers, and one or two English makers (Messrs. Rudge-Whitworth, Limited, and Messrs. Ryley, Ward, and Bradfield, makers of the "Tribune" cycle) make outward-cups crank-bracket bearings. It is instructive to look at the diagram illustrating the directions of the pressures on the pedal and on the bearings of the crank-bracket.

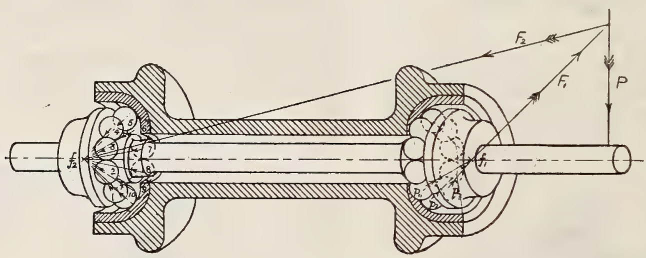


FIG. 10.

Fig. 10 shows diagrammatically a crank-bracket with the pedal pressure P applied at some distance outside both rows of balls. The pressure on the near row of balls will be confined to two or three balls near the bottom, and the direction of the resultant F_1 will practically coincide with the line of contact of the lowest ball. Now the axle is acted on by three forces, the pedal pressure and the resultant pressures F_1 and F_2 of the two rows of balls. Hence, by the well-known law quoted in all text-books of mechanics, these three forces must intersect at one point, and the direction of the pressure F_2 on the further row of balls is determined. F_2 passes through the point of intersection of F_1 and P, and through the virtual support f_2. Fig. 11 shows the force diagram drawn out, from which it will be seen that the pressure on each row of balls is very much greater than the pedal pressure P. The diagram is perfectly general, and can be applied to any case. I have here a wooden model, of about twice usual size, of an axle with a pair of loose cones which can be turned with their vertices outwards or inwards, and which illustrate experimentally the same facts. The cups are also of wood, and are not fixed in any way, but they are actually supported by a pair of pins projecting from the outer surface, the centre-line of the pin passing through the point of virtual support. One end of a spiral spring is attached to these pins, and the other to an adjustable screw bolt passing through a bracket fixed to the base of the apparatus. The only forces acting on each cup are the pressures of the balls and the pull of the spring; the latter, which is indicated at once in magnitude and direction, is therefore equal and opposite to the resultant pressure of the balls. The pressure corresponding to that exerted on the pedal is applied by a third spiral spring. On tightening up one or other of the springs, the axle with its bearings adjusts itself into its position of equilibrium. It has been tacitly assumed that the pressure on the ball-races is at right-angles to the axle; but if it be attempted to bring this spring supporting the near cup any nearer the vertical, the cup at once tilts and does not remain concentric with the cone. The spring may be brought nearer the horizontal, causing the other spring also to

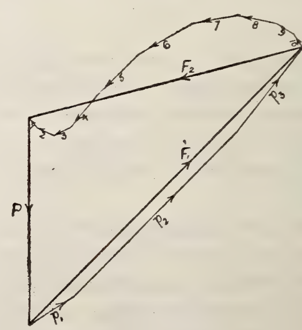


FIG. 11.

come nearer the horizontal. In fact, the direction of the resultant pressure F_1, must be a line passing through the virtual support f_1, and passing inside the ball-circle. The model is so arranged that the actual support can be

moved to the same plane as the ball-circles; in this case the cup tilts in the opposite direction.

The model is at present arranged as an inward-cups bearings, and for a pedal pressure of 15 lbs., the pressures on the ball-rows are 51 lbs. and 60 lbs. respectively. Mr. Ackermann will change it to an outwards-cup (cone-adjusting) type, and keeping the same distance between the rows of balls, we find that, for a pedal pressure of 15 lbs., the pressures on the ball-rows are 26 lbs. and 35 lbs. respectively.

The wall diagram or the model also shows clearly the effect of bringing the applied pressure nearer the ball-races. In the case of the pressure due to the pull of the chain, the pressure P may be applied very near the ball-race. If it be applied through the point of virtual support f_1, the pressure on the further row of balls is not zero, as many people imagine, but is actually an end thrust in the direction of the axle. On applying a pedal pressure of 15 lbs., passing through the virtual supports, I find the pressures on the bearings 15 lbs. and 27 lbs. respectively.

In a one-row ball bearing, as in the Quadrant pedal, the lateral stability depends essentially on the geometric conditions I have been explaining. If the pressures were at right angles to the axis, the one-row bearing could have no lateral stability.

I have designed a ball-bearing, with the object of reducing the frictional resistances to a minimum. The main rows of balls run between concentric cylindrical paths, and have therefore no power of resisting end thrust. This is taken up by a third row of balls, or by a row at each end, making in all four rows of balls. The spinning friction in this bearing is therefore reduced to a minimum, and is due only to the end thrust, not to pressure on the axle or hub. If the resistance of a ball-bearing were about 100 times what it actually is at present, this type of bearing might be of practical value. But as the frictional resistance of any decently made ball-bearing is very small, the additional complexity probably outweighs any advantage.

Fig. 12 shows Garrard's bearing for larger and heavier work, in which the same principle is developed more fully. The bearing illustrated is for a shaft 2 in. diameter, and a number of balls, several gross, rotate between slightly conical ball-paths fixed on the shaft and bearing case respectively. Adjustment for wear is provided, and end thrust is taken up by the ball-thrust bearings at the ends.

Dust-proof and Oil-retaining Bearings.—In comparing the two figures showing outward-cups and inward-cups bearings respectively, it will be noticed that if oil be supplied to the middle, it will be retained in the inward-cups bearing. The inward-cups bearing is therefore oil-retaining. The best cone-adjusting hubs are at present made with down turned lips, so that they are made slightly oil-retaining. Dust-proof washers are often supplied, which completely block up the space between the cup and the cone.

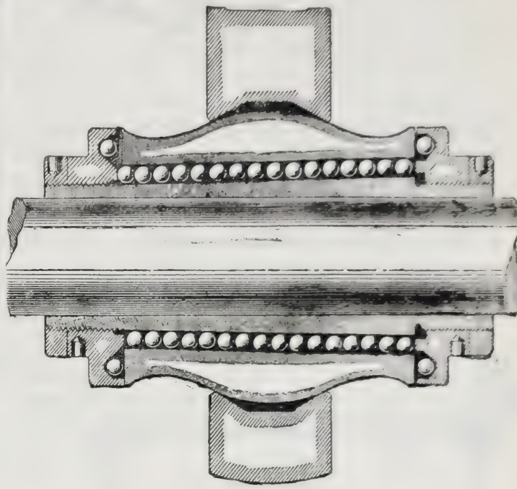


FIG. 12.

[A number of lantern slides illustrative of hubs, bottom brackets, and pedals, by various makers, were shown on the screen.]

Disc-adjusting bearings were first used by Humber and Co. for the bottom brackets, and

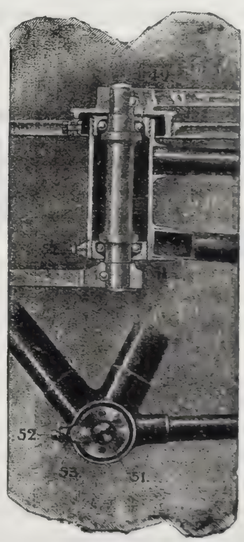


FIG. 13.

by the Elswick and the Centaur companies for hubs. Fig. 13 represents a section of the

Humber bottom-bracket bearing. Fig. 14, a view of the Elswick hub, with disc, washer, and locking-ring separate. The washer fits loosely on the disc, and when the latter is properly adjusted, one of the holes in the washer engages with a short pin projecting from the hub; the disc is thus prevented from turning. The locking-ring binds all firmly together. Fig. 15 is a view, partly in section, of the Centaur cup-adjusting pedal.

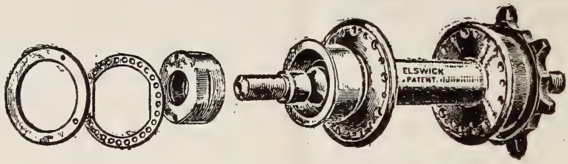


Fig. 14.

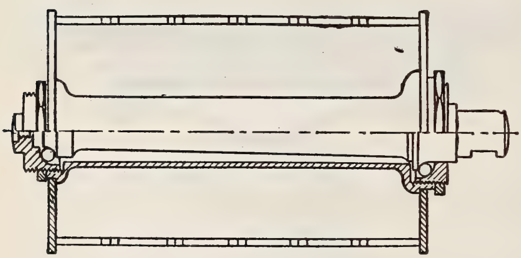


Fig. 15.

Figs. 16 and 17 are views of outward-cups crank-axle bearings used in the Rudge-Whitworth and Rambler bicycles respectively. The latter is cone-adjusting, the former cup-adjusting. In the Rambler bicycle, one of the cranks is forged in one piece with the axle. The other crank is cottered, and has three claws projecting from its boss to carry the chain-wheel, Fig. 18 (p. 773) is a section of the B.S.A. ball-head, a special feature of which is the spherical seatings for the ball-races.

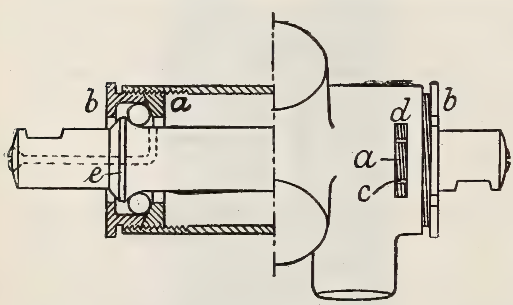


Fig. 16.

Fig. 19 (p. 773) is a section of the Quick Detachment hub, in which the cones are formed on a hollow spindle; the inner spindle fastening the hub to the frame can be withdrawn without disturbing the adjustment of the bearing, and the wheel can then be easily removed from the machine.

Wheels.—Most carriage and vehicle wheels are made with wooden spokes uniting the hub to the rim; the rim is made of segments of wood, and the whole construction is secured by an iron tyre shrunk on the wood rim. An initial compression is thus induced on the spokes, which is balanced by a circumferential tension on the combined rim and tyre. In bicycle wheels the stress conditions are reversed; the spokes are made of thin wire incapable of resisting compression. They are screwed up until a certain tension is obtained,

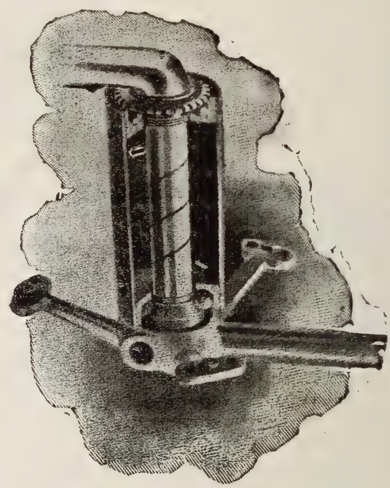


Fig. 17.

which induces a circumferential compression on the rim. Direct-spokes run radially from the hub centre to the rim. A direct-spoke wheel is quite satisfactory for the purpose of transmitting the load from the axle to the ground. But for driving, the direct-spoke wheel may not be rigid enough tangentially. If a driving effort be applied to the hub of a direct-spoke wheel, the hub rotates and the rim lags behind, until the centre-lines of the spokes all become tangential to a very small

circle. The driving moment applied to the wheel must be equal to the product of the total pull on all the spokes multiplied by the radius of this small circle.

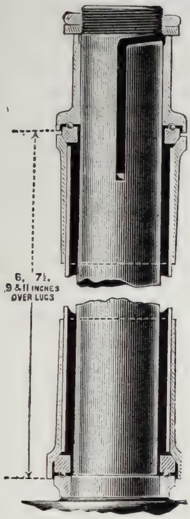


FIG. 18.

In a tangent-spoke wheel the spokes are arranged tangentially to a circle of considerable size as compared with the aforementioned one; and if the initial pull on the spokes be the same for all, one half are pulling at the rim tending to drive it forward, the other half tend to drive it back. The driving effort is transmitted by the pull on one set of spokes being slightly increased, that on the other set slightly decreased. For a given driving moment the stress on the spokes may be very much less than in the direct-spoke wheel.

FIG. 19.

Spread of Spokes.—If the spokes of a tension-wheel all lay in the same plane, the wheel would have very little lateral rigidity; any couple tending to move the spindle would distort the wheel. When the spokes are spread out at the hub, a bending-moment applied at the spindle would have the effect of increasing the pull on one pair of opposite spokes, and diminishing the tension on the other pair.

Rims.—The lateral spreading of the spokes of a wheel should be looked upon as a means of connectng the hub rigidly to the rim, rather than of giving the rim lateral stability relative to the hub. The rim must be of a form possessing sufficient lateral stability in itself, otherwise it cannot be built up into a good wheel. The lateral components of the pulls of the spokes tend to bend the rim sideways. If the rim be very narrow, as was the case with the solid tyres of the past decade, the liability of the rim to buckle is greater than with the wider rims used for pneumatic tyres.

[Specimens of rims, spokes, hubs, &c., by the Cycle Components Manufacturing Company, the Birmingham Small Arms Company, and the Jointless Rim Company, were exhibited. The rims made by the latter company are each cut from two square pieces of flat sheet steel, which undergo a process of spinning, until the required section is obtained; the two parts or rings are then soldered together. Also specimens of the Westwood, Hollow, Jointless Hollow, and C. C. Hollow.]

Wood Rims.—The question of wood *versus* steel for wheel rims is one that is not clearly understood, even by many engineers; but the mechanical principles involved are very simple. The strength of a rectangular beam subjected to bending is proportional to its width, the square of its depth, and to a coefficient depending on the strength of the material. The width of the rim for a pneumatic tyre must be practically the same whether wood or steel be used. I have here two beams of wood and steel respectively of equal width, length, and weight. It will be noticed that the steel beam is hardly strong enough to support its own weight, whereas the wooden beam is much stronger and stiffer. Roughly, the strength of steel may be taken 10 times that of wood. But the weight of steel is 10 times that of wood, and consequently, if the two beams be of the same weight, the wood beam is about 10 times as deep as the steel beam. So that, due to the increased depth, the strength of the wood beam is 100 times that of the steel beam, but, due to the smaller strength of the material, its strength coefficient is only one-tenth; the final result being that the wooden beam is about 10 times the strength of the steel beam of the same width and weight. Of course, no bicycle rim is exactly rectangular in section, and by curving the section, the strength of a steel rim is increased; so that comparing actual bicycle rims of steel and wood, the difference in strength may not be nearly so great as the above figures (for rectangular sections) show.

Materials.—To deal thoroughly with the subject, "Materials of Cycle Construction,"

would require a separate course of lectures; I can only refer briefly to the strength of some of the more important materials. If a load be applied at the end of a bar, and be gradually increased, the bar will ultimately break. If the bar be of one square inch section, the load on it at the instant of breaking is called the breaking tensile strength of the material. The effect of small loads on a bar is to distort its shape; if the stress applied does not exceed a certain amount, the bar recovers its original shape when the stress is removed. The elastic strength of a material is this limiting stress, and of course in any structure intended to last for a considerable time it should never be exceeded. If the elastic strength be exceeded, the deformation is more or less permanent, and the period of ductility or plasticity is reached. Now, steels of strength varying from 25 to 75 tons per square inch are used by engineers every day. Steel rails have an average strength of about 50 tons per square inch; the steel used in steam boilers, or for large bridges, has a strength of 26 to 30 tons per square inch. The question at once arises—why is the strongest steel not always used? This question can be better answered after having discussed the amount of mechanical work done in loading a bar. In loading a bar up to its elastic limit, the bar stretches slightly, and the applied load moves through a certain distance. The work done is a measure of the resiliency. The chief function of springs is the absorbing or storing up of a certain amount of energy or mechanical work, and restoring it again. When the elastic limit is exceeded, the stretch of the bar is much greater, and the amount of work required to actually break it is considerable. The relation between the stress, the deformation, and the work done on a bar can be best represented by a stress-strain diagram. In Figure 20, the stress on a bar at any instant is represented by the vertical ordinates, and the corresponding elongation by the corresponding abscissæ. Confining our attention to the stress-strain diagram for mild steel, curve A, as the load is gradually increased from zero up to about 30,000 lbs. per square inch, the elastic extension of the bar is proportional to the load. The total elastic extension, however, is so small (about 1-100th of an inch in a bar 10 inches long) that this portion of the stress-strain diagram practically coincides with the vertical axis. On further increasing the load, the elongation takes place at a quicker rate until when the stress indicated by the point *b* is reached, the material yields suddenly a considerable distance without any increase of applied stress. This goes on until the point *c* is reached, when to produce further elongation, a further increased stress is required. The relation between stress and strain is then indicated by the line *c d e*, *e* indicating the breaking point of the material, giving an elongation of about 25 per cent. of the original length of the bar. The work done in breaking the bar is indicated by the area between the base line of the diagram, the stress-strain curve and its ordinates, and may be said to be a measure of the toughness of a material. In a material like hard tempered steel there would be little or no elongation before fracture; and although its strength

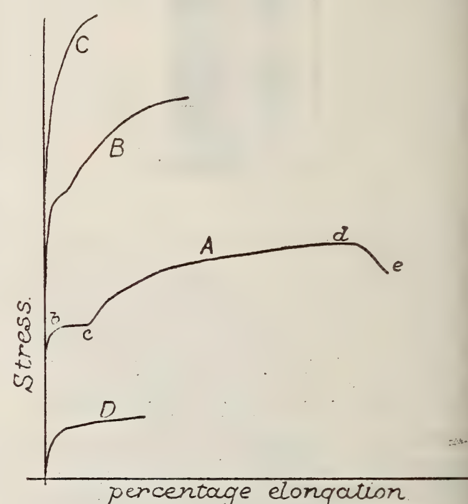


FIG. 20.

might be very great, its stress-strain diagram would be a line lying very close to the vertical axis, the work done in breaking it would be very little, and a slight concussion might be sufficient for fracture. Curve B shows the stress-strain diagram for a solid-drawn steel tube. Curve C that for the helical tube used by the Premier Cycle Company; this has a high tenacity, and a comparatively large amount of work is required to break it, it is therefore a very suitable material for cycle frames. Nickel steel has a very high tenacity, and a fair amount of elongation before fracture. Aluminium-bronze contains a very small proportion of aluminium, and is therefore a heavy alloy. Alloys containing a large per-centage of aluminium, and therefore light, have very low strength. Curve D shows the stress-strain curve for pure aluminium; a glance at the various

urves will show that aluminium is utterly unitable for use in a cycle frame.

Malleable Cast Iron is used by our best icycle makers for the lugs of the frame. rdinary cast iron is a material utterly united for use in a cycle frame; but by a process of cementation in furnaces extending over period of 7 to 14 days, the castings are conerted, by the removal of the contained carbon, nto malleable iron, a material having quite ifferent physical properties. The malleability an easily be demonstrated by smashing under hammer. Makers interested in steel stampgs or sheet steel lugs, sometimes try to throw iscredit on malleable cast iron lugs, but if roperly made they answer their purpose dmirably, even if they are a trifle heavier than heet steel lugs.

[*Sheet Steel Lugs*, by the Cleveland Machine crew Company, and by the Gormully and effery Manufacturing Company, as used in e "Rambler" bicycle, were exhibited; also number of internal liners, for reinforcing the ibes of the frame.]

Miscellaneous.

BUDAPEST ACETYLENE EXHIBITION AND CONGRESS.

An International Exhibition of Acetylene Appatus, combined with a Congress lasting five days, r the reading and discussion of papers dealing with e new industry, was held at Budapest last May. he Exhibition seems to have received more "official" cognition than is given in similar cases in this untry, for it was formally opened by the Hungarian inister of Commerce, while a Secretary of State, a ivy Councillor, and a member of the House of agnates took part in the inaugural ceremonies. ccording to the catalogue, eighty-six firms exhibited, cluding twenty-four from Germany, seventeen from ance, twenty-eight from Austria-Hungary, and the mainder from England, America, Holland, Italy, ussia, Sweden, Switzerland, and Roumania. The y was also more or less international in character, the principal European countries—except England being represented on that body. As the result of eir deliberations they distributed twenty-two gold edals, twenty-nine silver medals, and eighteen plomas, of which one gold medal, two silver medals, d one diploma fell to English exhibitors. Besides ordinary gas generators, there were on view a mber of other articles—purifiers and purifying terial, driers, burners and burner fittings, portable ps for cycles and carriages, samples of carbide, d models and diagrams of electric furnaces. With few exceptions, the apparatus, lamps, &c., were exhibited in actual work, so that the public should be in a better position to judge of their practical merits.

The general appearance of the stalls showed that great advances had been made in the construction of generators and kindred appliances during the year which had elapsed since the previous Exhibition held in Berlin in 1898; "freaks" were less conspicuous, the use of thin tin plate was far less common, much heavier metal was employed, and the machines were built more scientifically and mechanically. Indeed, according to a German writer, the 1898 Exhibition at Berlin appears to have been a little "too previous;" many of the generators were very faulty, the burners smoked, purification had not been investigated, and the general result was calculated rather to warn away possible purchasers than to make them enamoured of the new method of artificial illumination. But although progress during the last twelvemonth was evident from an inspection of the Budapest Exhibition, with the solitary exception of France, it was not so marked in other countries as it would have been had the budding industry not been crippled by the insufficient supply of, and exorbitant prices demanded for, carbide all the past winter. Many fresh works have already been constructed, others are still in course of erection, and before the long evenings come again, it is hoped that calcium carbide will be procurable without difficulty, and that its price will have settled down to a level corresponding more fairly to its actual value as deduced from the energy, &c., consumed in manufacturing it.

For the first time, so it is stated, the whole of the Exhibition at Budapest, indoors and out, was lighted by means of unprotected flames of acetylene made by the competing firms, some 2,500 burners being employed, which absorbed about 3 cwt. of carbide per hour. As pointed out by a critic on the spot, this arrangement, though perhaps a trifle dangerous in view of the number of generators shown in actual operation, was only judicious; for if the authorities of an acetylene exhibition act as though they were frightened of their own gas, how shall they persuade the public to adopt it?

The papers read during the Congress were of two classes, a series of popular lectures were given on the properties and use of acetylene by various authorities in order to disseminate correct information among the visitors; and a number of technical communications on points of interest to the carbide manufacturer and generator maker were delivered by experts from several countries.—*Engineer*.

ELECTRIC POWER AT NIAGARA.

Professor George Forbes, F.R.S., who read a paper before the Society on December 14th, 1892, on the "Utilisation of Niagara," has written the following letter from Niagara to the editor of *The Times* on the recent development of the enterprise:—

"It was with unmixed pleasure that I have been able to pay a long-promised visit to Mr. W. B. Rankine, one of the vice-presidents of the Niagara Falls Company, to see how the commercial developments at Niagara were progressing; and I believe that a concise statement may be of interest to your readers. In June, 1892, and again in December, 1894, when the first works were nearing completion, I gave in *The Times* some account of what was being done, and since then the public has taken much interest in similar electric developments of water-powers.

"It is $4\frac{1}{2}$ years since I was last here, and the first thing to strike one is the great number of enormous new factories which have been established on the company's land. Nearly every one of these consumes a very large amount of power, as is shown by the following statement, which any one can verify, showing the names of the factories and the amounts of power used in each :—

	h.p.
International Paper Company	7,200
Pittsburg Reduction Company (aluminium)	3,050
Carborundum Company	1,000
Buffalo and Niagara Falls Electric Light Co.	500
Electro - Chemical Company (peroxide-of-sodium)	400
Buffalo and Niagara Falls Electric Railway	200
Niagara Falls and Suspension-bridge Railway	250
Buffalo and Lockport Electric Railway	350
Oldbury Electro-Chemical Company	1,000
Mathieson Alkali Works	2,000
Cataract Power and Conduit Co. (Buffalo)	3,000
Tonawanda Power Company	500
Union Carbide (of Calcium) Company	10,000
Surface Coating Company (enamelling)	20
Niagara Development Company (workmen's dwellings)	75
Niagara Waterworks	45
Total	34,590

"To these additions are to be made in October, and two new works, the Atchison Graphite Company and the Lead Reduction Company (Litharge), will be supplied, bringing the total up to 45,190 horse-power contracted for, bringing in an income of over £150,000. The operating expenses do not exceed £25,000 per annum.

"This is a most interesting result in three ways—(1) It shows that the original promoters were right in believing that the locality, with cheap railway transport, was favourable; (2) it shows that the general plan of the works, by which any customer could have any kind of electric current he desired, has been appreciated; and (3) it gives an indication of the enormous strides which have been taken of late years in electro-chemical and metallurgical processes.

"Regarding the machinery, the dynamos, which were totally new, not only in size but in their general design, never give the slightest trouble; and the transformers, ranging up to 2,500 horse-power, have answered their purpose perfectly, even with the low frequency of alternations, which was generally con demned by theorists when I introduced it, but whic is recognished now by every one at Niagara as con tributing largely to the success of the scheme. Th rotary transformers, for converting alternating int continuous current, which are used for nearly half o the power, gave some trouble at first, being the firs which had ever been commercially used. But th difficulties have been successfully met. A good dea of the other machinery was of a new character, an bold in design, but has generally worked well. Th setting-up and working of the transmission line t Buffalo reminds one of the earlier electric ligh stations in the United States, but this is bound to b one of the most important applications in the futur

"The general conclusion arrived at, after thoroughl inspecting everything under the best auspices, is tha the boldness of the originators of the scheme has bee justified, and that the wants of manufacturers wh require power in any form can be supplied. It mus be remembered, however, that much depended upo the favourable locality, and this warning may b given, that it would be rash to develop a large wate power in this way without demands for power. A the inception of all these schemes there is one thin more important than overcoming the engineerin difficulties, and it consists in ensuring the support o those who require large quantities of power, electric or mechanical."

LAC AND ITS SOLUTIONS.

The British Journal of Photography contains a article on this subject, from which the following ex tracts are taken. The article is written in referenc to the use of lacquer for photographic lenses an camera fittings, and was suggested by a letter from correspondent asking for particulars in regard t lacquer. "Up to a few years ago," says the corre spondent, "we were able to make an exceedingl good lacquer for our brasswork, the colour was pecu liar, and was much admired for our class of worl The last few years, however, we have had grea trouble with our lacquer; in the first place, th druggists refused to let us have the spirit unless the was something put into it, and we had to get th lacquer made up by the druggists. Now, howeve we have got a license from the Excise people, i order to get the spirit ourselves, and yet we cann get the same class of lacquer we got in forme years. . . . Some twelve or fifteen years ago I trie a great number of experiments about lacquer, an used all sorts of colouring materials, but I found tha although I could get almost any colour I liked wit suitable dyes, these colours were liable to fade. . . I finally got the very best result by using nothing bu seed-lac . . . . a beautiful lacquer, just the colour w wanted. . . . I have tried various specimens of seed lac lately, and can get nothing like the old result," &c

Before solving this riddle, which we think we sha

lo readily, we should like to refer a little more in letail to the varieties of lac found in commerce. It s a rather singular fact, in connection with an article f such importance as lac, that the literature on the ubject should be so sparse and the facts so variously tated. It is known to be associated with the life iistory of a little insect. The insect appears in vast iumbers on the small twigs and branches of certain rees; the insects die after depositing eggs, and the wigs are found covered with an incrustation variously tated to be dead bodies of the female insects, a secreion exuded by them, or an exudation from the tree aused by punctures made by the insects. This we nay leave to be settled by experts. The incrustation s there, and the twigs which they cover are collected. These twigs are termed "stick-lac." Seed-lac is the iame given to the incrustations after being removed ind triturated in a mortar, with the double object of lissolving the colour out of them (which colour is the asis of the famous lac dye) and reducing the little umps to small pieces. Seed-lac forms the principal ngredient in many of the older recipes for lacquer at i time when methylated spirit had not been devised. Now, unless the natives have invented factitious seedac, it is quite evident that seed-lac at the present ime cannot be any different from what it was fifty or i hundred years ago, so that any difficulty in making acquer must be sought elsewhere.

Incidentally let us describe the production of hellac. The seed-lac is collected and placed in anvas bags, which are heated sometimes before a harcoal fire, and at others over a fire. When heated o melting, the bags are twisted, and the lac drops out. If received into water, it forms "button lac." When smeared, so to speak, over the smooth surface of a portion of the plantain tree, it hardens and lakes off in the form of shell-lac. This shellac is of various degrees of translucency and colour. The inest is known as orange lac, and its quality is gauged by its glass-like transparency and the lightiess of tint. The poorer qualities, as before described, are called "ruby," "garnet," &c., according to the depth of colour. "Lump-lac" is simply a nelted agglutination of seed-lac. We have thus a complete key to the colour, and an explanation of the preference given to seed-lac. It is unaltered by the iand of man, and so possesses the virtues of gum-lac n the highest degree, and is accompanied by a porion of the original colouring matter, which is nothing out the well-known lac dye, one of the fastest of red lyes—the material used for dyeing the best quality of he soldiers' "red coats." The old lacquer makers preferred to modify and deepen this colour by adding various vegetable colours, notably gamboge, annato, saffron, and very frequently aloes. Many makers idded sandarac and other gums to their lacquer to idd to its brilliancy, though we are inclined to think hat any addition whatever reduces its resistance to nechanical injury.

There is then only the solvent left to consider, and iere we do not doubt the key to the mystery is to be found. Our correspondent is probably unaware that the methylated spirit of to-day is different from that of a dozen years ago. The new kind, as we have often stated, is made by adding a light petroleum oil to ordinary alcohol, the mixture being incorrectly termed "methylated." This name is only truly given to the old kind. The addition to the alcohol in that kind consisting of methyl alcohol, known also as wood spirit, wood naphtha, pyro acetic spirit, &c. If our correspondent will ask the Inland Revenue authorities to revise his license and alter it to a permission to use the old kind of methylated spirit, we think all his difficulties will vanish. With regard to the solvents, there can be no doubt that something beyond a mere solution of the lac is needed, for it is well known that the users of French polish prefer either all wood naphtha, or a least a large proportion of naphtha in the liquid they use. Finally, we append two very old and tried recipes for lacquers of different colours, which we know were in use more than half a century ago:—

Shellac	120	parts.
Sandarac	45	,,
Mastic	30	,,
Amber	30	,,
Black resin	90	,,
Dragon's blood	30	,,
Turmeric	30	,,
Gamboge	30	,,
Rectified spirit	1000	,,

Shake occasionally till dissolved and strain.

Seed-lac	120	parts.
Gamboge	120	,,
Dragon's blood	120	,,
Saffron	30	,,
Rectified spirit	1000	,,

Put in a hot place, stir at intervals, and filter.

HIGHER EDUCATION OF WOMEN IN GERMANY.

The movement in Germany to open new callings for women, and to make them economically independent, has, during the last few years, met with marked success. In various cities, societies have been formed for the establishment of girls' colleges. H.M. Consul-General at Frankfort says that in Karlsruhe there is already such an institution. Also in Cologne, a society, "Verein Mädchen Gymnasium," is planning the organisation of a college with nine classes for girls, the sixth class of which is to be opened in 1900. In Hanover a girls' college is to be opened, which, as a commencement, is to begin with the upper third class. The school fees are to be 160 marks (£8). The object of the school is to enable pupils to pass the matriculation examination for admittance to the universities. The Senate of the University of Giessen has decided by a large majority to admit women as students, and also to attend different lectures as if they had matriculated. A

necessary condition is the certificate of having passed the examination at a gymnasium, or "real gymnasium," viz., a school of first rank. At the University of Berlin, at the commencement of 1899, the first female was presented with her doctor's diploma. It appears that general regulations regarding the admittance of women to regular study is now imminent in Germany, inasmuch as the various separate societies have pronounced themselves in its favour.

THE MINERAL PRODUCTION OF CANADA IN 1898.

An interesting summary of the mineral production of the Dominion of Canada for 1898 has been issued by the Canadian Geological Survey; and in a recent report, the United States Consul at Toronto states that although the returns are not yet all in, the summary shows that the output for the year 1898 is considerably in excess of that of the previous year. Of the total output of metallic products, valued at £4,323,000, £2,750,000 was gold, £2,000,000 of this representing the yield of the Yukon district. Silver (fine, in ore, &c.) was produced to the value of £516,000. The other metals were copper (fine, in ore, &c.), £430,000; nickel (fine, in ore, &c.), £365,000; lead (fine, in ore, &c.), £240,000; and iron ore, £30,000. The output of non-metallic substances was £3,177,000, of which coal represented more than half, viz., £1,650,000. Building material (including bricks, building stone, lime, sand, gravel, and tiles) was valued at £720,000; petroleum, £196,000; asbestos and asbestic, £97,000; and Portland cement, £196,000. The estimated value of the mineral products not returned is put down at £50,000, thus bringlng the total value of the mineral product of the country last year to £7,550,000, or £1,820,000 more than 1896, when the value was £5,730,000. There was an increased output of coal in all the different districts, and a gain of 50 per cent. in the output of copper in the province of Ontario. There has also been an increase in the output of nickel, but a decrease in lead, silver, and asbestos.

Obituary.

ROBERT WILHELM BUNSEN, FOR. MEMB. R.S.—The renowned chemist Bunsen died on the morning of the 16th inst. at the great age of 89. He was born in 1811, and graduated at the University of Göttingen as Ph.D. in 1831. He succeeded Wöhler as Professor of Chemistry in the Polytechnic School at Cassel in 1836, and after several changes he was appointed to the chair of experimental chemistry at Heidelberg in 1852, and he remained there in spite of an invitation to Berlin until his resignation in 1889, after which he lived in retirement at Heidelberg. Bunsen's fame is so wide and his biography has been so often written that it is unnecessary to enumerate here his claims to distinction. It will suffice t enumerate some of the honours awarded to him i England. He was elected a Foreign Member of th Royal Society in 1858, and in 1860 the Copley Meda was presented to him by that body. The first awar of the Davy Medal in 1877 was jointly to Bunsen an Kirchhoff for their researches on the solar spectrum He was elected an Honorary Corresponding Membe of the Society of Arts in 1896, and last year th Albert Medal was awarded to him "in recognition c his numerous and most valuable Applications c Chemistry and Physics to Arts and Manufactures."

COLONEL WILLIAM ROWE LEWIS.—Colon Lewis, of the Sussex regiment of Artillery, an Commandant of the Sussex Artillery Volunteer died on the 3rd December, 1898, at the age of 7 and was buried in the picturesque churchyard c Sedlescombe. He commenced life as a Ci Engineer, and was a pupil of Brunel, but he left th profession early in life, and settled at his home a High Beach, near Battle, as a country gentlema He was a Justice of the Peace, Chairman of th School Board, member of the County Council an of the Highway Board. He was greatly intereste in literary and scientific questions, and was a memb of several societies. He was elected a member c the Society of Arts in 1884.

WILLIAM SIMPSON, R.I.—Mr. Simpson, the wel known artist and foreign correspondent, died on Thur day, 17th inst., at his home at Willesden. Althoug he was not a member of the Society of Arts, he wa an active member of the committee of the Applie Art Section, and took a great interest in the work c that Section. He was born at Glasgow, October 2 1823, and was employed by Messrs. Day and So in London in 1851 as a lithographic artist. On th outbreak of the Russo-Turkish War in 1853, he pr ceeded to the Crimea to make sketches of the cam paign, and his lithotints of the Seat of War, whic were published in two folio volumes, and are no highly valued as a fine historical example of boo illustration, ranking by the side of the beautif work of David Roberts in the Holy Land. I 1866, he joined the staff of the *Illustrate London News*, and he remained connected wit that paper until his impaired health compelled his r tirement. He was at the fall of Sebastopol, at th opening of the Suez Canal, and at the capture c Magdala. He was in China in 1871–2, and visite the Great Wall. He accompanied the Prince c Wales to India in 1875, and in 1877 he visite Mycenæ and the Troad. Mr. Simpson read sever papers of interest before the Society as follows:– In 1872, "Symbolism of Oriental Ornament;" i 1878, "Mycenæ, Troy, and Ephesus;" in 1879, "A Vestiges in Afghanistan;" in 1886, "Experiences o the Afghan Frontier;" in 1888, "What Style of Archi tecture shall we follow;" in 1891, "Lithography, Finished Chapter in the History of Illustrative Art; and in 1892, "Mud a Material in Persian and Easter Architecture." He received the Society's silve medal for the paper on "Lithography."

Journal of the Society of Arts.

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FRIDAY, SEPTEMBER 1, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1900.

The dates fixed for the Examinations in 1900 are Monday, March 26th; Tuesday, 27th; Wednesday, 28th; and Thursday, 29th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix, containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, W.C.

Proceedings of the Society.

CANTOR LECTURES.

CYCLE CONSTRUCTION AND DESIGN.

By Archibald Sharp, A.M.Inst.C.E.

LECTURE III.—Delivered March 6, 1899.

Cranks.

In modern bicycles, with very few exceptions, the power of the rider is applied to a pair of pedals carried at the ends of a pair of cranks. The length of the crank of the safety rear-driver has been, up till a year or two ago, usually from 6 to 6½ inches; but recently, Mr. Crompton and Herr Blathy have experimented with much longer cranks, up to 9½ inches in length, with correspondingly high gear, and the results obtained have been such, that now long cranks can easily be obtained. It may be said at once that the question of the most suitable length of crank is a physiological one rather than mechanical. The claims advanced by the advocates of long cranks have been stoutly resisted by hard riders, who have been in the habit of using cranks of normal length. The latter contend that the increased sweep of the leg must conduce to stiffness, saddle soreness, and a host of other imaginary evils. Many of them have actually tried the long crank, so that their opinions must be entitled to due consideration. The little personal experience I have had of the long crank has led me to look upon it with great favour. On four separate occasions I have had rides, varying in length from 40 to 70 miles, and on no occasion did I experience the discomfort predicted by the short crankists; on the other hand, I found the long slow sweep of the thigh a more exhilarating motion than that provided by the crank of normal length. It is possible that a hard rider, who travels 10,000 miles per annum, several years in succession, with 6½-inch cranks, gets muscle-bound; and does find a longer crank uncomfortable and inconvenient. His experience, however, may be utterly misleading as a guide for the average rider, who is content with 1,000 miles per annum, or less. The latter would get more quickly accustomed to long cranks than the former. Anyone who is disposed to experiment with long cranks and high gear, may safely do so without fear of being considerably out of pocket if the experiment ends in failure, as far as he is concerned personally. The long crank and high gear machine with its longer wheel base, and high crank bracket, makes an excellent machine for shorter cranks. Looking at the question mechanically, and regarding the legs and feet of the rider as a mechanism which in its working must absorb a certain amount of friction, the total work done by the rider may be divided into two parts, the external work communicated to the pedals, and the internal work absorbed in friction of the joints, muscles, and ligaments. Making reasonable assumptions, I have deduced figures which show a slight advantage in favour of long cranks, but so small, that the only safe deduction from my premises is that there is no reason why the long crank should not at least be as good as a 6½-inch crank. Fig. 1 is intended to show the extreme movement of the leg when pedalling with cranks of various length. The sixteen sketches are arranged in four columns showing cranks of 5, 6½, 8, 9½ inch cranks respectively. The four figures in the top row are drawn with the saddle in the highest possible position consistent with the rider reaching the pedal at its lowest point. An ankle action of 70° is assumed in each case, the length of the thigh from hip-joint to knee-joint is 16 inches, the length of shank from knee-joint to ankle-joint is 16½ inches;

the length of foot from ankle-joint to the centre of the pedal is 6 inches.

The angles swung through by the hip, knee, and ankle, are shown numerically in Table I., p. 781. If the internal work expended in swing-

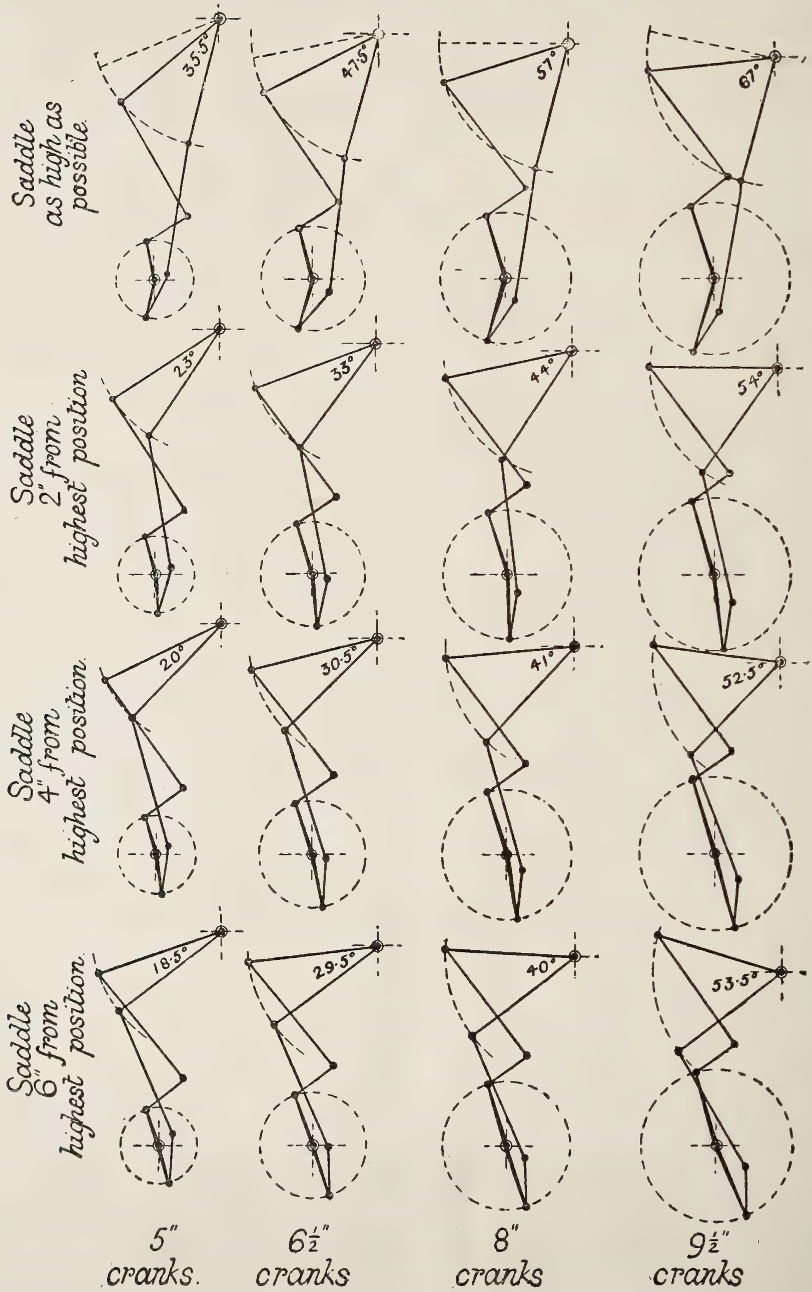

FIG. 1.

ing the ankle, knee, and hip joints through 1° be assumed proportional to 1, 2, and 3, the relative internal work for any case is found by adding together the ankle angle, twice the knee angle, and three times the hip angle; the numbers so obtained are tabulated, and can be compared with each other.

It will be noticed, from Fig. 1, that while the knee moves from its highest to its lowest point, the crank in most cases moves through less than two right angles. If the pressure applied to the pedal were always in the direction of the line joining the knee to the pedal pin; as would be the case with an inanimate arrangement of links and levers, there would be

TABLE I.

LEG AND ANKLE ACTION IN PEDALLING.

Saddle position.		5 in. cranks.	6½ in. cranks.	8 in. cranks.	9½ in. cranks.
Highest possible.	Hip angle .... degs.	35	47	57	67
	Knee angle .... degs.	81	100	113	126
	Ankle angle .... degs.	70	70	70	70
	Internal work .... ∝	337	411	467	523
	Per-centage loss ... ∝	67	63	58	55
2 in. lower.	Hip angle .... degs.	23	33	44	54
	Knee angle .. .. degs.	55	72	91	97
	Angle angle .... degs.	70	70	70	70
	Internal work .... ∝	249	313	384	426
	Per-centage loss ... ∝	50	48	48	44
4 in. lower.	Hip angle .... degs.	20	30	41	52
	Knee angle .... degs.	48	64	79	87
	Ankle angle .... degs.	70	70	70	70
	Internal work .... ∝	226	288	351	400
	Per-centage loss ... ∝	45	44	44	42
6 in. lower.	Hip angle .... degs.	18	29	40	53
	Knee angle .... degs.	44	61	71	82
	Ankle angle .... degs.	70	70	70	70
	Internal work .... ∝	212	279	332	393
	Per-centage loss ... ∝	42	43	41	41

a period between the end of the driving action of one crank, and the beginning of the driving action of the other. This period has been called the "dead angle" by M. Bourlet ("Nouveau Traité des Bicycles et Bicyclettes"). It will be noticed that the dead angle is reduced by lowering the saddle, is zero for a 6½-inch crank with the saddle 6 inches below its highest possible position, and is actually negative for the 9½-inch crank with saddle 6 inches below highest position, in other words, the driving arcs for the two cranks overlap. Now I will not contend that the latter is therefore the best of the sixteen cases shown in Fig. 1, but I am inclined to believe from these diagrams, from my own riding experience, and from observations of the practice of racing men, that most cyclists, especially ladies, ride at present with their saddles too high for the best results.

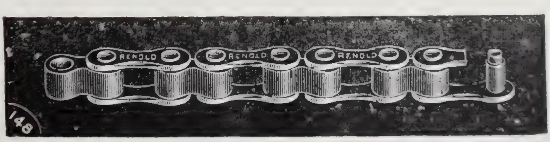

FIG. 3.

Fig. 2 shows the shapes of the sections of cranks — rectangular, round, oval, trough-shaped, diamond-shaped, and T-shaped. At the pedal end of the crank the principal straining action is a twisting-moment, and the best shape to resist this stress is circular. At the other end, the principal straining action is a bending-moment, and the best section to

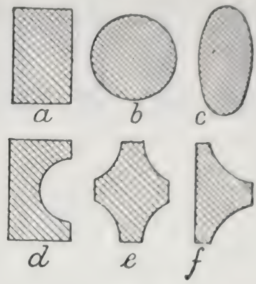

FIG. 2.

resist this stress is rectangular. The sections *a*, *b*, *c*, *d*, may be said to be suitable, but the sections *e* and *f* are unsuitable, since the greater part of the material lies near the neutral axis of bending. The total weight of a crank, however, is so small, that manufacturing operations are perhaps the most important factor in their design.

CHAINS.

In nearly all modern bicycles the power has to be transmitted from the crank-axle to the hub of the driving-wheel, and the chain is the transmitter usually employed. The Morgan chain as used in the very early tricycles was made up of a series of tubular rollers alternating with links. Fig. 3 shows the block chain as made by Mr. Hans Renold. In the block chain the rivets uniting the pairs of side-plates rest in cylindrical bushes in the blocks of the chain. Messrs. Perry and Co. were the first to use specially hardened bushes of pen-steel, to protect the comparatively soft rivet from rubbing on the block. Fig. 4 shows diagrammatically the construction of the roller chain. In this, instead of a block, a pair of inner side-plates, which are united by a pair of tubular sleeves, are employed. The rivet uniting the outer side-plates has this tubular sleeve as its bush. A live roller surrounds the sleeve and comes directly in contact with the teeth of the chain-

wheel. Thus the rubbing of the blocks along the wheel teeth with a block chain is replaced by the rubbing of the roller on the sleeve. The wearing surface, instead of being a narrow one near the end of the block, is distributed round

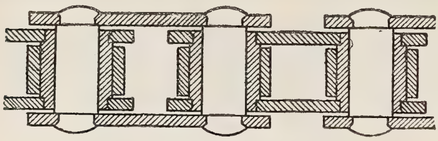

FIG. 4.

the entire surface of the roller. [Exhibit of chains.] In all roller and block chains of the usual type the rivet rubs on the block or the sleeve, as the chain bends or unbends in passing on or off the chain-wheels; this rubbing being of course accompanied by a certain amount of friction. In the pivot chain made by the Cycle Components Company, an attempt is made to eliminate this friction by the substitution of a knife-edge support for the rivets. The Morse chain (Fig. 5) is somewhat similar in design.

cranked with the object of making all links exactly alike instead of alternately in pairs. Fig. 7 shows $\frac{1}{2}$-inch pitch roller chain, as

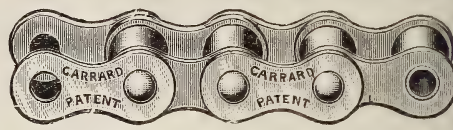

FIG. 7.

made by the Garrard Manufacturing Company, and of which there are specimens on the table. In the best modern chains the side-plates are made quite straight with their axis of symmetry coinciding with the axis of the pull.

Stretch of Chains.—It is found that chains gradually elongate under the severe stresses to which they are subjected in ordinary working. The word "stretch" does not quite express what happens. Possibly there is little or no actual stretch of the side-plates, but the bearing pressure of the rivets and sleeves on the side-plates is so great that deformation gradually takes place, which in the aggregate is

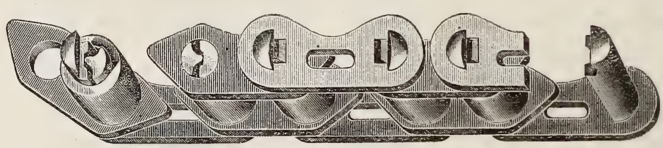

FIG. 5.

[An experiment was made on an apparatus lent by the Cycle Components Manufacturing Company, showing that the knife-edge friction was much less than that of a rivet in a cylindrical bush.]

Strength of Chain.—The side-plates of a chain are subjected to a tensile stress, the rivets and tubular sleeves to bending and shearing stresses. The side-plates should therefore be made quite straight, so as to resist the pull as directly as possible; similarly the rivet and sleeve should be made capable of resisting bending stresses. In the old roller chain 1 inch pitch, each half of the sleeve was made in one piece with the inner side-plate; consequently, if the rivet pressed uniformly on the sleeve, the line of pull of the inner side-

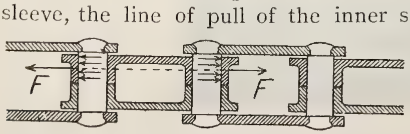

FIG. 6.

plate would not coincide with the middle of the side-plate. (Fig. 6.) In another form of 1 inch pitch roller chain, the side-plates were

manifested as an elongation of the chain. In the roller chain of $\frac{1}{2}$-inch pitch the dimensions of the rivets and sleeves are possibly nearly as small as they can be made with a fair amount of durability. The roller chain of $\frac{5}{8}$-inch pitch has much greater margin of strength in this direction.

Chain Wheel.—The teeth of chain-wheels perform quite different functions from those of spur and bevel gearing. If the pitch of the chain-wheels be exactly equal all that is necessary is that pockets for the blocks or rollers should be cut out below the pitch-polygon of the wheels. The portions of the teeth projecting above the pitch-polygon act nearly as guides for the chain so that the blocks or rollers enter the pockets properly. The function of the teeth is therefore analogous to that of a funnel used for pouring liquids into a narrow necked bottle. Fig. 8 shows the principles underlying the design of the proper shape to be given to the teeth of the chain-wheel; *a*, *b*, *c*, *d*, are centres of consecutive rollers in contact with the chain-wheel, they therefore form the corners of the pitch-polygon. As the motion of

the wheel continues in the direction of the arrow, the roller a will soon leave the wheel. The relative motion of chain and wheel will be the same if we consider the wheel fixed, and unwind the chain in the direction opposite to

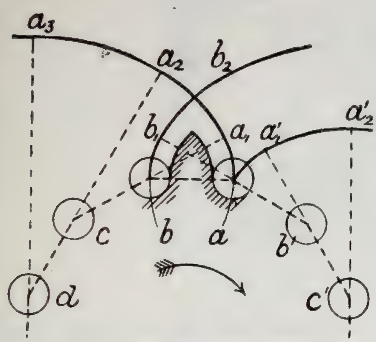

FIG. 8.

the arrow. It will thus be seen that the centre of the roller a will move along the circular arc aa_1, having the point b as its centre. The links ab and bc being then in line, the further motion of the roller a is along the circular arc, a_1a_2, having the point c as a centre. Similar consideration will show that when the tooth gets near the on-coming chain the path of the roller b will be the curve formed by the series of circular arcs, b, b_1, b_2, having the centres b and a respectively. If a pair of curves be drawn parallel to those curves, the fullest possible tooth outline will thus be determined, as shown by the shaded outline. With such a tooth outline, the rollers will rub along the whole length of the tooth.

of the chain to mount the wheel. If the centres of the tooth-outlines be taken slightly inside the pitch-polygon the chain will enter and leave the wheel more freely, but if this be overdone the chain will tend to mount the wheel. Fig. 9 shows the tooth outline adopted by the Garrard Manufacturing Company for the teeth of wheels for their ½-inch pitch roller chain.

Variation of Speed.—The number of revolutions in a given time of the crank-axle and the back hub are inversely proportional to the numbers of teeth on their respective chain-wheels. But since the pitch surfaces of the chain-wheels are not circular but are polygons, the speed-ratio does not remain constant. In a roller chain-wheel with six teeth the variation of the speed is 7·8 per cent. With 12 and 24 teeth on the back hub the variation is 1·8 and 0·4 per cent. respectively.

Noise of Working.—Each link of the chain as it comes into contact with the chain-wheel strikes it with an appreciable speed. If the chain-wheel revolves in the direction opposite to the arrow (Fig. 8), the motion of the rivet a, relative to the chain-wheel as it strikes the latter is one of rotation about the centre b. Thus for a given speed of rotation, the shorter the links the less is the speed of striking, and the less is the noise of working. For a given pitch and speed of rotation the speed of striking is therefore independent of the number of teeth in the chain-wheel. This probably accounts for the smoothness of action of the ½-inch pitch roller chain.

Friction.—The frictional resistance of chain

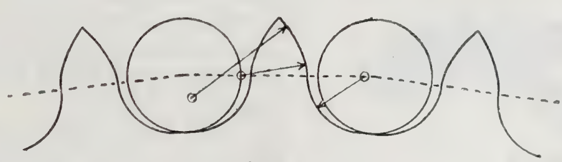

FIG. 9.

The design of the teeth of wheels for block chains can be made in exactly the same way, the radius of the end of the block being taken instead of that of the roller. But as there is no necessity for the blocks rubbing along the whole length of the tooth, the points of the tooth can be reduced; if the centres for the tooth-outlines be taken a little closer together than the corners b and a of the pitch-polygon, the blocks will not rub along the teeth when the pitches of the chain and wheel are exactly equal. The outlines of the teeth at the pitch-polygon are still exactly perpendicular to the sides of the polygon, and there is no tendency

gearing is very complex. Reference had already been made to the rubbing of the rivets on the blocks or sleeves. The amount of this rubbing is quite definite, and during one revolution of each chain-wheel the rubbing of the rivets is equal to one rivet making a complete revolution in its block or sleeve. Then there is the *rubbing of the blocks along the teeth.* If the pitch of the chain and wheels be exactly equal this may be zero. With a new chain the pitch of the driver wheel is a little greater than that of the chain and the acting tooth is near the bottom (Fig. 10), and as the driver rotates, the block a_1 a_2 ultimately leaves the chain-

wheel and in so doing rubs along the tooth, *A*. When the chain has stretched so that its pitch

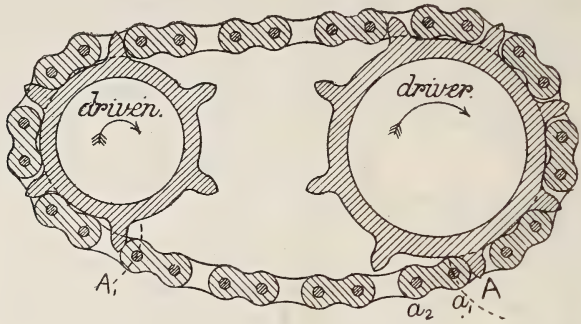

FIG 10.

is slightly greater than that of both chain-wheels the acting teeth are at the top (Fig. 11)

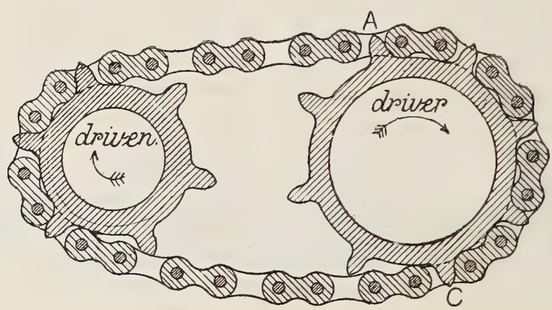

FIG. 11.

and the amount of rubbing of the blocks on the teeth is much less. Fig. 12 shows the block

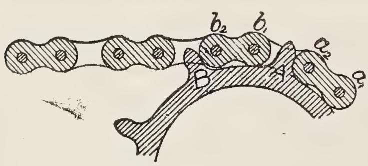

FIG 12.

end, b_2, just coming into contact with the tooth, *B*, and Fig. 13 shows it bedded on the seating.

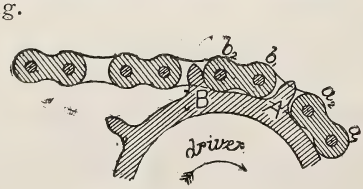

FIG. 13.

The blocks also rub along the seating of the chain-wheels if there be any difference in the pitches.

As the end, *a*, of the block leaves the seating of the chain-wheel (Fig. 10) the end a_2, turns in contact with the tooth, *A*. During a complete revolution of the wheel the total friction due to this action is the same as if the end of the block turned through half a revolution in contact with the wheel. When the chain has stretched so that its pitch is slightly greater than that of the chain the acting tooth is at the top and there is no friction due to this cause. (Fig. 11.)

Some experiments on the friction of chains have been made by Professor Carpenter who has found the frictional loss, in some cases, to be less than half of 1 per cent.

Gear-case.—The possible sources of frictional loss being so numerous, if the best results are to be obtained, the chain and wheels should be protected from mud, grit, and dust, and if possible should be surrounded by an oil-bath gear-case. A naked chain may absorb 4·7 per cent. of the rider's power, although it may not be very appreciable to him in ordinary riding.

Chain Adjustment.—Provision has to be made for adjusting the chain as it stretches. Fig. 14 shows the well-known eye-bolt and nut adjustment for the back-hub, as made by the

Cycle Components Manufacturing Company, Limited. Eccentric adjustment for the spindle frame-tube, and neat gear-cases enclose both pairs of bevel wheels.

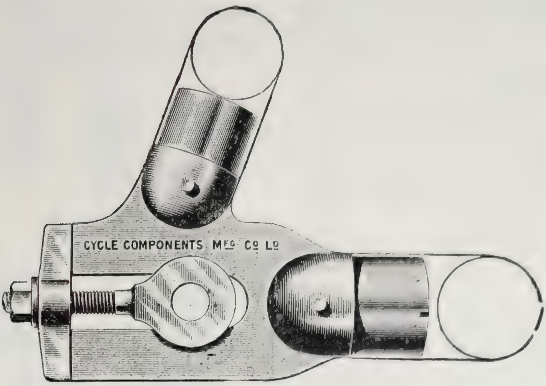

FIG. 14.

of the driving-wheel is being largely used. Fig. 15 shows the volute cam chain adjustment

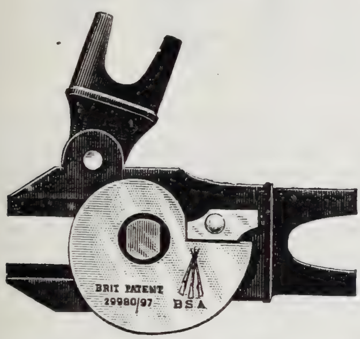

FIG. 15.

made by the Birmingham Small Arms Company, Limited. In this a pair of volute cams are placed on the ends of, and turn with the spindle, and bear against fixed stops. The nuts at the ends of the spindle being loosened the spindle is turned, when the volute cams force it backwards, tightening the chain. The spindle is then locked in position by its end nuts.

In the Columbia chainless bicycle, the intermediate shaft rotates inside the frame-tube, and the front pair of bevel wheels are enclosed in the crank-bracket chamber, an outside bearing being screwed on the end of the crank-bracket chamber. The intermediate axle is inserted in position from the rear, hence the necessity for the short bridge-piece to carry the driving-wheel spindle.

The Sterling chainless gear differs from the Columbia mainly in the fact that the large bevel wheel is near the middle of the crank-axle, and therefore engages with the opposite side of the small pinion. The large crank-axle wheel being in this case on the opposite side of the intermediate shaft, as compared with the arrangement adopted in the Acatene and Columbia machines, necessitates the intermediate spindle being prolonged beyond the centre of the driving-wheel. With this arrangement both gear-cases can be incorporated with the frame of the machine. It has the further advantage that as the angle between the wheels of each pair is reduced, the relative

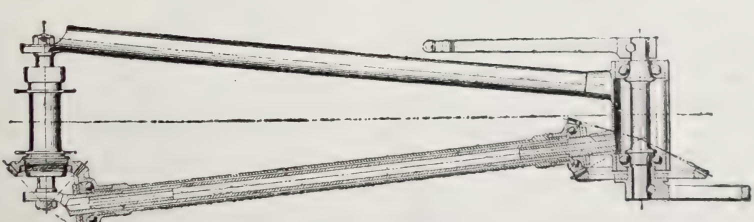

FIG. 16.

Bevel Gears.—Fig. 16 shows the Acatene bevel gear for bicycles. In this gear the intermediate shaft rotates on the outside of the motion of the teeth on each other is less, and the friction of the gear is considerably reduced, as can be shown as follows.

In Fig. 17 two bevel wheels are shown in gear, rotating in the direction of the arrows A and B. The speeds of rotation (number of revolutions) are inversely proportionate to the

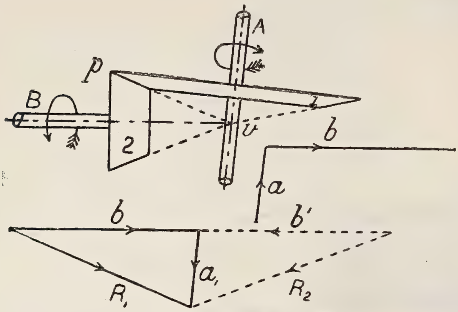

FIG. 17.

diameters, and can be represented in magnitude and direction by vectors a and b, in the directions of the shafts and of lengths proportionate to the speeds. The directions of the arrows a and b must be such that the rotations A and B appear either both clockwise or both counter-clockwise. Now the friction of the toothed wheels depends (other conditions remaining unaltered) upon the relative speed of the wheels. This can easily be found by supposing the whole mechanism, including the wheels and the frame, to be given a rotation equal and opposite to a. This is indicated by the vector a_1. The wheel 1 will thus be brought to rest, and the wheel 2 will roll round it, its instantaneous axis of rotation being $v.p$. The rotation of the wheel 2 is now the resultant of a_1, and the original rotation b, and is indicated in magnitude and direction by R_1. If the speed-ratio and angle between the shafts be kept the same, but the wheel 1 be brought to the other side of 2, the resultant relation would be R_2. Thus the ratio of the frictions of the Sterling and Columbia bevel gears is the ratio of R_1 to R_2.

Cross-roller Gear.—The Quadrant cross-roller gear, of which there is a specimen on the table, may be described as a roller crown gear, consisting of a pair of discs from which pins project at right angles, each pin being surrounded by a roller. Fig. 18 shows a well-known case of two equal wheels with parallel shafts rotating in the same direction, and with their centres apart a distance equal to the sum of the radii of the pins or rollers. Similarly, Fig. 19 shows a cross-roller gear in which the kinematic action is exactly the same. It will be noticed on comparing these two figures that the same pair of roller wheels may be used in each case; so that the angle between the shafts makes no difference in the condition of correct working, provided of course that th rollers are long enough to mesh with eac other. This practically means that the adapt ability and flexibility of the cross-roller gea

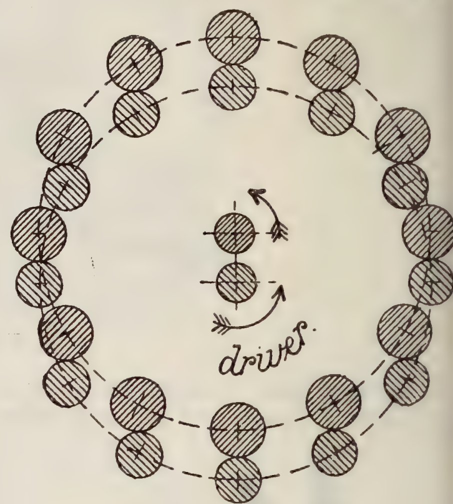

FIG 18.

exceeds that of any other mechanism used for cycle driving. This is a property of great practical importance, in so far that distortion to the frame either through careless workmanship or accident does not affect to any appreciable extent the easy running.

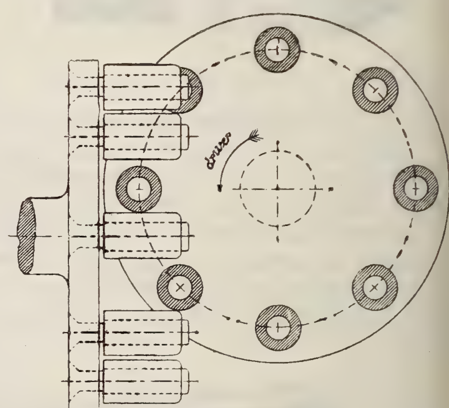

FIG 19.

As regards the frictional resistance, the only appreciable item is the rubbing of the rollers on their pins, and as they are always enclosed in neat gear-cases with a liberal supply of oil, under ordinary touring conditions, the cross-roller bicycle should compare favourably with the best chain-driven bicycle, and should be superior to a naked chain of whatever type. Fig. 20 shows a horizontal section of the gear.

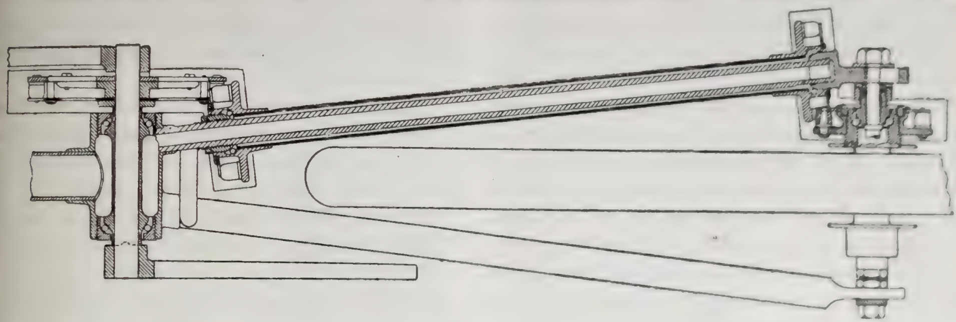

FIG. 20.

A bevel roller gear, Fig. 21, was made a short time ago by the Wilkinson Sword Company, in which one wheel of each pair carried a series of rollers which geared with a solid toothed wheel.

A pair of wheels each with circular teeth or rollers will not gear together with exactly constant speed ratio. I have investigated the subject of designing wheels with circular teeth or rollers in which the variation of the speed ratio should be reduced to the smallest possible amount.* A bevel roller gear with 24 and 18 rollers respectively has a speed variation of 0·9 per cent.

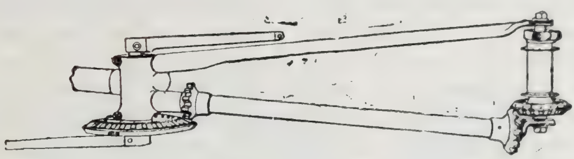

FIG. 21.

Front-driving Gear.—Fig. 22 shows a view of the Crypto epicyclic gear for front-driving bicycles. When the speed ratio is $1\frac{1}{2}$, a disc prolongation of the crank axle carries four small pinions which gear with a toothed wheel fastened to the hub, and a concentric toothed wheel fixed to the fork of the bicycle. When the speed ratio of the hub and axle is $2\frac{1}{2}$, the hub toothed-wheel is smaller than the fork toothed-wheel.

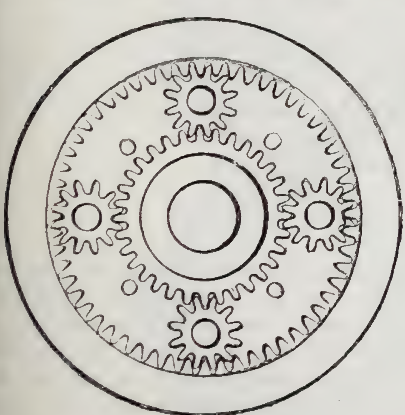

FIG. 22.

Two-speed Gears.—The question of two-speed gears and free pedals depends largely on statistics. If a rider and machine weigh 200 lbs., and if the greatest comfortable pedal pressure be 75 lbs. and be exerted vertically downwards, a gradient of 1 in 10 can be climbed with a gear of 30 inch. Such gradients are rare, and therefore it may be said that under no conceivable circumstances can a gear lower than 30 inch be recommended. At the other extreme when running down a slight slope, or going along the level with the wind at one's back, the machine will run by itself, and if free pedals are provided, the feet may remain at rest. If the gradient be steeper, either back pedalling or the application of a brake is necessary. The resistances to be overcome in propelling a bicycle are due to (1) friction of the mechanism, (2) rolling resistance of the tyres on the ground, (3) vibration and jolting due to rough roads, (4) air resistance, (5) gravity when ascending hills (when descending hills gravity, of course, accelerates the motion). The best gear for a bicycle is that which will allow the rider to move his pedals at the speed most convenient for him developing his power, and at the same time proportion the speed of the machine to that of the pedals, so that the work done by the rider shall be just equal to that required to overcome the resistances. But

* "Proc. Inst. Civ. Eng.," vol. 121, pp. 237-279.

since four out of the five resistances enumerated vary considerably from moment to moment it follows that in the ideal bicycle the gear should also vary. A two-speed gear is not a mechanism transmitting more power to the driving wheel of a bicycle than the rider delivers to the pedals, it is simply the means of giving closer approximation to the ideal best gear under widely varying conditions than is possible with a single-speed machine. If the per-centage of time during which any particular gear is the ideal best could be tabulated it might be possible to arrive at a definite conclusion as to the best arrangement of a two-speed mechanism. In a two-speed gear the question of the ratio of the high and low speed is of importance. If the diagram shown were a fair representation of the requirements; two gears of 60 and 75 would be about the best. In the present form of the "Collier" two-speed gear the gear ratio is 20-17, giving a difference of 18 per cent. for the high above the low; this I find suits my own personal convenience for speeds of 12-14 miles an hour over the fairly level roads lying to the west of London. At lower speeds or in more hilly districts, a 25 per cent. difference is very suitable; while I think a difference of more than 33 per cent. cannot be advisable under any circumstances.

no appreciable change in the action of pedalling. In the Beaumont two-speed gear two chains are used.

An epicyclic gear in the back hub forms the basis of a great number of two-speed gears, *e.g.*, the Reilly and Haigh, the Planet. In the Planet two-speed gear, made by Mr. Telford C. Field, Planet Works, Southampton, the high is 58 per cent. above the low gear.

An internal gear, consisting of a spur pinion working inside an annular wheel, is the basis of the Collier two-speed gear, and of the Brown-Lipe gear fitted to Rambler bicycles. The former is applied at the crank-bracket and the internal gear is in operation at high speed. The chain-wheel turns on a ball bearing at the end of the bracket, and the crank-axle is carried on a hollow axle, the centres of the axles being a short distance apart. At low speed the crank-axle, hollow-axle, and chain-wheel are all locked together and rotate as one solid piece. Change from high to low speed can be effected at two points in a complete revolution of the pedals, from low to high at only one point.

Fig. 23 shows the Brown-Lipe two-speed gear at high gear, Fig. 24 at low gear; the former is 25 per cent. above the latter. The hub chain-wheel, 1, runs on a ball-bearing on an eccentric, 10, which turns on a portion, *e*,

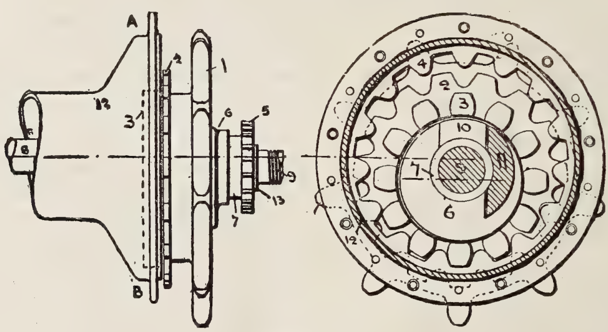

FIG. 23.

The mechanisms of the two-speed gears in practical use at present are of three types. In one type the change of speed is effected by altering the number of teeth on the axle or hub chain-wheel. In the Protean gear (which gives four speeds) the number of teeth on the crank-axle chain-wheel is either 18, 19, 20, or 21, and can be altered while riding. The ratio of the highest and lowest gears is therefore 21 : 18; *i.e.*, the highest is 16·6 per cent. above the lowest gear. The chain-wheel is circular when 19 teeth are in operation, and slightly oval at the other speeds; but there is

of the spindle set eccentrically with the axis 8, of the hub, A B. Thus, the chain-wheel may be brought co-axial with the hub (Fig 24) or eccentric therewith (Fig. 23). In the latter position the annular wheel, 4, on the hub is driven at a lower speed than the chain-wheel by the internal pinion, 3. In the former position the narrow toothed-wheel, 2, fits into the corresponding toothed-wheel, 4, on the hub. In changing from one speed to the other, the eccentric, 10, has to be moved axially along the spindle, *e*, and in an intermediate position the chain-wheel is quite free

rom the hub. The complex motion of the eccentric sleeve, 10, is obtained by means of a slotted cam in which a pin engages; the rotation of the eccentric is effected by a rack operated by the rider, and engaging with the toothed-pinion, 5. It will be noticed that the chain line is not exactly the same at high and low speeds, the axial deviation of the hub chain-wheel being about 1-8th of an inch, *i.e.*, one-sixteenth of an inch on each side from the straight.

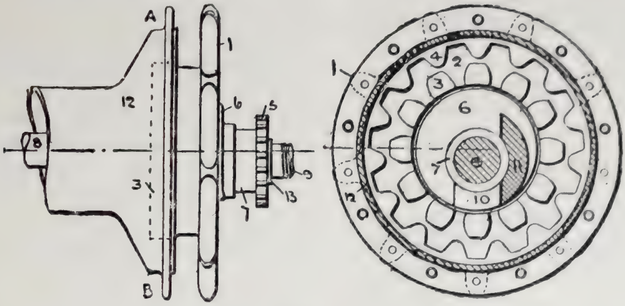

FIG. 24.

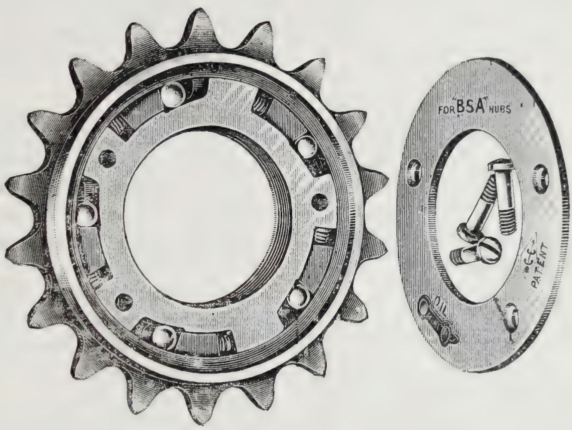

FIG. 25.

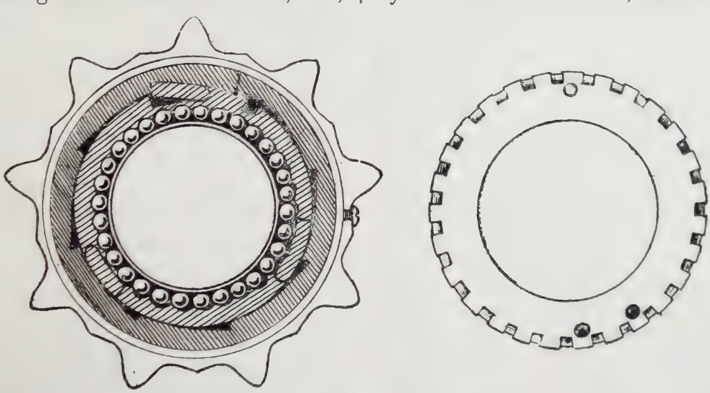

FIG. 26.

Free Pedals.—The greatest activity of cycle designers at present is manifested in free pedal devices, which have for their object the freeing of the pedals from the driving wheel of the cycle when there is no necessity for the application of driving effort, *e.g.*, when running down hill, or along the level after attaining a fair speed. The hub chain-wheel drives the hub by an automatic clutch, which is released as soon as the forward driving effort ceases. Fig. 25 shows the roller clutch made by the

Cycle Components Manufacturing Company, Limited. Each roller tends to move towards the narrow end of the cavity in which it is placed, so long as a forward driving effort is exerted, and therefore the chain-wheel is immediately jammed tight on the central portion permanently fixed to the hub. If the hub tends to move faster than the chain-wheel each roller tends to move towards the wide end of its cavity, and the connection is broken. In order to ensure that the clutch shall come into operation immediately, a forward driving effort is exerted, each roller is pressed by a block and spiral spring towards the narrow end of its cavity. Fig. 26 shows the ratchet clutch as used in the Beaumont free-wheel device. There are three loose pawls passed outwards of weak springs, and eight notches in the chain-ring. One of the pawls catches one of the notches when a driving effort is exerted, but if the hub tends to over-run the chain-wheel, the arrangement of the pawls and notches allows this to take place.

The Juhel gear is a free-pedal device, combined with a pedal backing brake, the whole of the mechanism being contained at the back of the hub.

Miscellaneous.

PROGRESS OF SANITATION.

On Tuesday, 29th ult., the newly-elected President of the Sanitary Institute (Sir William Preece, K.C.B., F.R.S.) delivered his inaugural address at the Hartley Institute, Southampton. After expressing the pleasure he felt in being once more in Southampton, where he had spent fifteen of the busiest and happiest years of his life, he said that the greatest sanitary engineer the world had ever known was Moses. The Book of Leviticus was a treatise on hygiene. For 3,400 years the world stood still, and only one race followed the doctrines and teachings of that great master. The Christian threw his tenets to the wind—the Mahomedan, to his great benefit, had continued to practice some of his principles to the present day. The Jew remained faithful, and was the healthiest and longest-lived type of humanity. The doctrines of Moses could be summed up as the objects of sanitation to-day:—(1) Pure air, (2) pure water, (3) pure food, (4) pure soil, (5) pure dwellings, (6) pure bodies. There were three very important principles underlying all the practical applications on sanitary engineering:—(1) Energy, or the ability to do work; (2) chemistry, or the power to transform matter; (3) life. The sun being the centre and spring of all energy, it was the function of the engineer to apply this principle of energy to the comfort, happiness, and health of man.

Pure Air.—The supply of pure air to those who breathed it was the object of ventilation. Moses did not legislate for ventilation, for dwellings in Egypt, as in the East generally, were open to the heavens. The Israelites dwelt in tents, but he showed how to prevent the pollution of air by the decomposition of refuse, for he ordered it to be carried out without the camp into a clean place and there be burnt. We were only now learning to follow Moses's lead, for refuse destructors were quite a modern and up-to-date "invention." We were even utilising their heat for the generation of steam for electric-lighting generating stations, and we were thereby economising waste, the highest function of the engineer. After pointing out that the air became vitiated by artificial light, such as candles, oil, and gas, and that one ordinary gas lamp acted as five persons in this respect, he said the British Legislature had taken care that lunatic asylums, hospitals, workhouses, and gaols should be well provided with proper air space per person, whereas churches, chapels, theatres, meeting-halls, assembly-rooms, railway carriages, and other places where healthy, honest, and well-to-do people congregated were totally neglected and remained sinks of discomfort.

Pure Water.—Referring to the question of water supply, he asked, Should there not be a duplicate supply, one for domestic and the other for public purposes? This was already done at Richmond and St. Helens. Sea-water was used at Great Yarmouth and Bournemouth for watering the streets.

Pure Food and Pure Soil.—It was in the regulation of the food supply of the Israelites that Moses displayed his profound knowledge of the hygienic requirements of the Eastern nations, and it was by adhering to these regulations to the present day that the Jews lived such healthy lives. Legislation as affecting adulteration of food, the importation of meat, the sale of drugs, fruit, fish, &c., was probably simple, but the enforcement of the regulations, the control of supervising powers, and the appointment of inspectors was weak. Referring to the disposal of sewage, the President said that one of the best examples of water carriage discharging into the sea was at Portsmouth, where Sir Frederick Bramwell, taking advantage of the direction and velocity of the tidal currents of the Solent, had disposed of the crude sewage so as to avoid any possible nuisance or interference with the enjoyment of those who frequented Southsea beach. Sir J. Bazalgette did the same at Torquay, while Brighton and Margate were excellent examples of similar good sea disposal.

Pure Dwellings.—Speaking of pure dwellings, the President said that people suffered not alone from ignorance, but from carelessness and filth. The lower the social scale and the greater the weakness of education, the more callous and indifferent human beings became to cleanliness and comfort; improvidence, the curse of drink, crime, and vice were to be ameliorated only by education and example.

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FRIDAY, SEPTEMBER 8, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1900.

The dates fixed for the Examinations in 1900 are Monday, March 26th; Tuesday, 27th; Wednesday, 28th; and Thursday, 29th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix, containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, W.C.

Proceedings of the Society.

CANTOR LECTURES.

CYCLE CONSTRUCTION AND DESIGN.

By Archibald Sharp, A.M.Inst.C.E.

Lecture IV.—Delivered March 13, 1899.

Rolling Resistance.—When a wheel rolls over a smooth horizontal surface there is a resistance to its motion, termed rolling friction. Professor Osborne Reynolds has investigated the nature of rolling resistance, and he finds that it is due to actual sliding of the surfaces in contact. No material in nature is absolutely rigid, so that the roller has an area of contact, the extent of which varies with the material and the curvature of the surfaces in contact. When an iron roller rests on a flat thick sheet of india-rubber, the roller sinks into the rubber, and lines originally drawn parallel to each other on the india-rubber are distorted. The vertical compression of the layers of rubber below the centre of the wheel causes them to bulge laterally, while the vertical extension of the layers in front and behind the centre of the wheel causes them to get thin laterally. This creates a tendency to a creeping motion of the roller along the rubber. This action is such that the distance actually travelled by a roller in one revolution is different from its geometrical circumference, the difference in some cases amounting to 2 per cent.

When rolling takes place at any appreciable speed, there is another factor that must be considered. A tyre of a circular wheel rolling on a flat surface gets flattened out, the pressure in front of the geometrical centre of the wheel opposes, and the pressure behind assists, the rolling of the wheel. If the rolling takes place slowly, it is possible that these two pressures may be equal; but in all reversible mechanical actions taking place quickly it is found that there is a loss of energy, which varies with the quickness of the action. In unloading a spring quickly the load corresponding to a given deformation is less than when loading it, more work is required to load the spring than is given out by the removal of the load. The same kind of action takes place between two bodies in impulsive collision, like a pair of billiard balls. The time of contact of a pair of billiard balls may be divided into two portions, during which their centres are approaching and receding from each other. The pressure at any period during approach is less than the corresponding pressure during recess; the ratio of the two pressures being called the *index of elasticity*. In the case of a tyre rolling over a smooth surface, where e is the index of elasticity, and x the vertical distortion, the energy lost is proportional to $(1-e)x$. Comparing three tyres of rubber, air, and steel respectively, rolling on a perfectly hard surface, $(1-e)$ will be possibly smallest for air and largest for rubber; while the displacement x will be the smallest for steel. The rolling resistance of the steel tyre will be the least, that of the rubber tyre the greatest. If absolutely smooth, hard steel tracks could be had for cycling, it is possible that the best results would be attained by having hard steel tyres, as in railway vehicles.

Tyres on Roads.—In moving over an ordinary country road, the nature of the resistances is quite different. The road surface is seldom quite hard and elastic; if a hard metal tyre be driven over a soft road it sinks into it, and leaves a groove of quite appreciable depth. A hard steel tyre sinks further than a narrow solid rubber tyre, and this again further than a pneumatic tyre; the resistances to motion are proportionate. In running over an obstacle, the resistance experienced depends largely on he nature of the tyre. Let a wheel be sup-

posed to move over an undulating road so that it rises without sudden jerk to a height h, the speed being so great that when the wheel is at its highest point it is clear of the obstacle and of the ground. In this case the energy due to the fall from the height h is entirely wasted in shock, there being no means of obtaining a forward impulse from the work done during the descent. If the wheel strikes the object suddenly, and then rises to the height h clear of the ground and the obstacle, the energy lost will be greater than in the former case. If the motion over the obstacle be so slow that the wheel remains in contact with it, the energy of descent of the wheel may be utilised in propelling it forward, and if the reactions on the wheel as it goes on and off the obstacle are equal, there would be no loss of energy. With a hard unyielding tyre this is not even approximately true, except at very low speeds. With a tyre that can adapt itself *instantaneously* to the inequalities of the road, the reactions during rolling on and off are equal, and there is no loss of energy. The pneumatic tyre is a much closer approximation to such an ideal tyre than is an iron or a rubber tyre.

Other things being equal, the loss of energy in moving over a stone or a rough road will be proportional to the weight of the machine which partakes of the vertical motion. In a rigid frame bicycle with iron tyres, as in the old boneshaker, practically the whole weight of the machine had to be lifted, with a rubber tyre the vertical motion of the whole machine was much less, while with the pneumatic tyre the vertical motion may be confined to a fraction of an ounce weight of the part of the outer cover in contact with the obstacle.

The tyre resistance of a bicycle is always much greater than that of the mechanism, and at low speeds is the largest factor in the total. At a speed of 10 miles an hour the air resistance is about equal to the tyre resistance, while at higher speed the resistance of the air is by far the most important. The resistance of the pneumatic tyre is approximately constant at all speeds, so that the power required to overcome it is proportional to the speed. The air resistance, on the other hand, is nearly proportional to the square of the speed, and the power required is proportional to the cube of the speed.

Pneumatic Tyres.

When a pneumatic tyre rests on the ground, and supports a vertical load, a part of the tyre is flattened, and this flattening goes on until the air pressure on the flat portion is exactly equal to the weight supported by the wheel. Thus, the harder the tyre is pumped the less is the area of contact with the ground. Probably the only appreciable resistance of a pneumatic tyre is that due to bending and unbending the cover. The amount of this bending is least when the air pressure is greatest, consequently on a smooth track the tyres should be pumped hard.

The air-tube has merely to form an air-tight vessel to retain the air under pressure.

The outer cover has a variety of functions to perform; firstly, it must be sufficiently strong transversely and longitudinally to resist the air pressure; secondly, in a driving-wheel, or in a wheel to which a brake is applied, it must be strong enough to transmit the tangential effort from the rim of the wheel to the ground; thirdly, the tread must be thick enough to stand the wear and tear of riding on a rough road, and to protect the air-tube from puncture; fourthly, though offering great resistance to elongation it should be as flexible as possible, offering little resistance to flexure as it comes into and leaves contact with the ground.

As regards the stress on the fabric, this is proportional to the air pressure, proportional to the thickness of the tyre, and inversely proportional to the thickness of the fabric. Further, the stress on a transverse section is half that on a longitudinal section, so that if the air pressure be excessive the tyre bursts by tearing longitudinally.

The first pneumatic tyres were made with canvas having the fibres running transversely and circumferentially. In this case no driving effort could be transmitted from the rim to the ground until the fabric was distorted through a considerable angle. In the tangential fabric now almost universally used, the fibres are arranged spirally, sloping 45° to the mean circumferential line. When a driving effort is being exerted, the portion of the tyre near the ground is subjected to a shearing stress as before; but this is equivalent to a tensile stress and a comprehensive stress in directions inclined 45°; consequently the spiral fabric is much better able to transmit the driving effort from the rim to the ground. This construction is undoubtedly the best for driving-wheel tyres and for wheels to which a brake is applied; but the front wheel, if no brake be applied, would perhaps better have a tyre with the fibres arranged transversely and circumferentially. The tyre with spiral fibres has

another curious property:—On inflation, the diameter of the tube forming the tyre tends to increase, while the diameter of the tyre, as a whole, tends to decrease, so that the act of inflation tends to tighten the tyre on the rim. This follows from the fact that the tensile strength in the transverse direction is twice that in the circumferential direction, so that the fabric tends to lengthen transversely, and to shorten circumferentially. In the single-tube tyre on the table the diameter at present, when fully inflated, is $26\frac{1}{4}$ inches, on deflation the diameter increases to 28 inches.

As regards flexibility, a woven fabric in which the fibres intermesh with each other is much stiffer than the Palmer or Flexifoot fabrics. In these, the fabric is made up of two layers, in each layer the fibres lie side by side, and are embedded in a thin sheet of india-rubber, the fibres of one layer are arranged at right angles to those of the other. This arrangement gives greater strength and greater flexibility than a woven fabric of the same weight.

Classification of Pneumatic Tyres.—Pneumatic tyres may be divided into three classes, as follows:—

Class 1 has complete tubular outer covers. Tyres of this class can be inflated when detached from the rim of the wheel; in fact, the rim is not an integral portion of the tyre as in the two following classes. The original Dun-

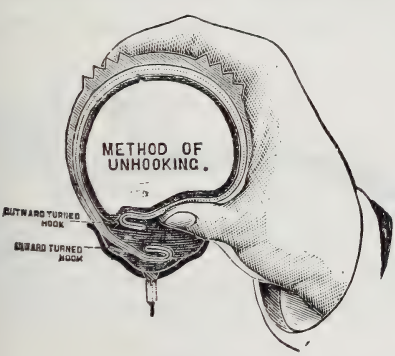


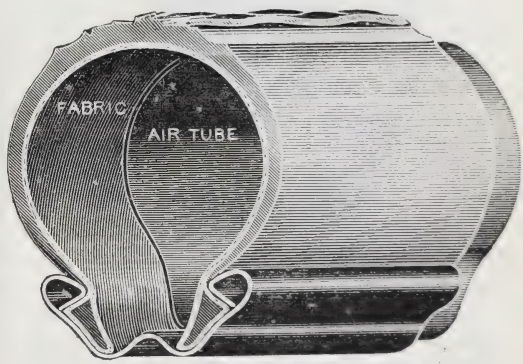
FIG. 1.

lop tyre belongs to this class, so do all single-tube tyres, and the Woodstock tyre (Fig. 1) is an example of a detachable tyre belonging to this class. In the Gormully and Jeffery tyre (Fig. 2) there is a slight action of this kind caused by the interlocking of the flap.

Class 2 consists of tyres in which the transverse tension on the outer cover is transmitted to the edge of the rim, so that the outer cover and rim form one continuous tubular ring, subjected to internal air pressure, and to trans-

FIG. 2.

verse tension. The Clincher, Welch-Bartlett (Fig. 3), Palmer, Fleuss (Fig. 4, p. 794), Trench (Fig. 5, p. 794), and Gormully and Jeffery tyres are examples of this class. The outer covers in this class have slightly extensible edges, so that they can be drawn over the edges of the rims.



The Welch-Bartlett Tyre.

FIG. 3.

Class 3 consists of tyres in which the transverse tension on the outer cover is transmitted to the edges of the latter, and there resisted by the longitudinal tension of inextensible wires. The Dunlop-Welch tyre (Fig. 6, p. 794) is the best known example of this class; the Warwick tyre also belongs to this class. The Warwick tyre has one coil of wire embedded in each edge of the outer cover, while the present pattern of the Dunlop-Welch has a triple coil.

The triple coil is made from a thinner wire, the edge of the tyre is therefore rendered more flexible, and a greater facility of attachment

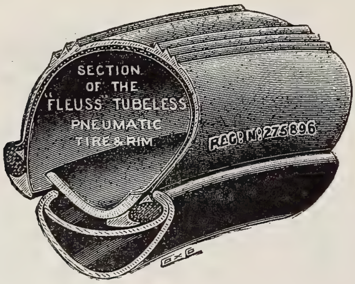


Fig. 4.

and detachment is secured. Fig. 7 illustrates the mode of detachment, one part of the wired edge of the outer cover being depressed into the central channel of the rim, the opposite part projects beyond the edge of the rim, and can easily be pulled over. The pressure between the wire and the rim is at right angles to the surface of the latter, while it is also at right angles to the direction of the stress in the preceding class.

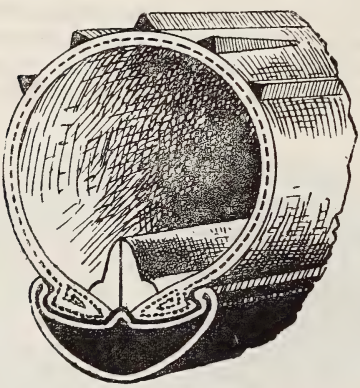
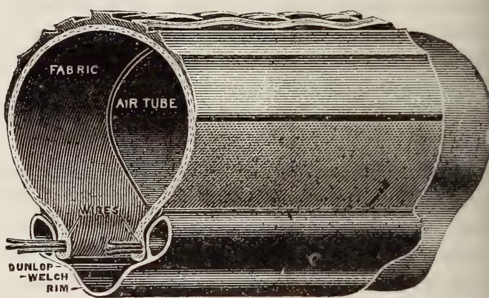


Fig. 5.

Single-tube tyres, of which the Hartford is a representative specimen, have the fabric, the outer layer of rubber, and the inner air-tube all vulcanised together. The alleged difficulty of repair has prevented this class of tyre from being extensively used in this country, although in America they form by far the greatest number in use, the sales in the United States during the year 1897 being said to be a million and a half. As to resiliency, it is claimed that a single-tube tyre can be made more resilient than one with separate air-tube and outer cover. This is a matter that can only be satisfactorily dealt with by experiment.

Side-slipping.—Newton enunciated the first law of motion thus :—"Every body continues in its state of rest or of uniform motion in a straight line, except in so far as it may be compelled by applied forces to change that state." Applying this to the case of a bicycle running on a horizontal surface, it continues moving in a straight line until the frictional resistances bring it to rest. In driving at a uniform rate the driving force just balances



The New Dunlop-Welch Road Racing Tyre.
Fig. 6.

the forces of resistance. When a body moves in a circular path, some force must be acting on it tending to deviate it from a straight line. Thus, when a stone attached to the end of a piece of string is whirled by hand, there is a continual pull by the string at the stone directed towards the centre of the circle in which it is moving, and, conversely, the stone pulls at the end of the string with an equal and opposite force. The latter is called centrifugal

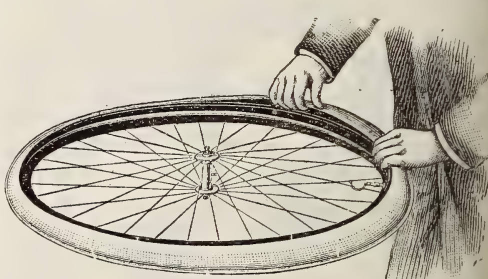


Fig. 7.

force, the former centripetal force. When a bicycle is running in a curved path, there must be a force acting on it directed towards the centre of the circle. The centrifugal force (to use the popular term) is proportional to the weight of the bicycle to the square of its speed, and inversely proportional to the radius of curvature of the path at the instant. If the motion takes place on an horizontal plane, the centrifugal force is resisted by the side

friction of the tyres on the ground. If there were no side friction, bicycle riding would be impossible. A surface of smooth ice approximates to one with no side friction, and it would be a difficult matter to ride on such a surface with the ordinary type of tyre. While moving round a curve the rider automatically leans towards the inside, so that the resultant of the centrifugal force and the weight of the machine and rider passes through the line joining the points of contact of the wheels with the ground. The chance of side-slipping will be reduced to a minimum if the surface of the ground in a lateral direction is at right angles to the slope of the machine. Thus, the banking of racing tracks must be made proportional to the square of the speed, and inversely proportional to the radius of the track. Thus, comparing two tracks for mean speeds of 20 and 40 miles an hour, the slope of the latter at any particular radius should be four times that of the former. A study of the slope of these curves for tracks of small radii will reveal the fact that at high speeds a vertical wall is safer to ride on than a horizontal floor. I do not know whether the feat has been performed by acrobatic trick riders, but should not be surprised if someone worked the idea into his display.

The side-slipping of a bicycle depends on the co-efficient of friction between the wheels and the ground, and the angle of inclination of the bicycle to the vertical. If the co-efficient of friction is great, the chance of slipping is small; if the co-efficient of friction is small, as with smooth tyres on muddy or greasy roads, the chance of side-slipping is greatly increased. It follows from what has already been said that no sharp turns should be made on greasy roads at high or even moderate speeds. To make such turns the bicycle must be inclined to the vertical, the slope increasing with the square of the speed and with the curvature of the path; when the angle of slope from the vertical exceeds the friction, a side-slip ensues.

In ordinary riding the lateral, unavoidable swing of a "safety" is greater than that of an "ordinary," in which the mass-centre of the rider is very much higher; hence side-slipping is much more frequently met with in safeties; in fact, side-slipping was practically unknown to users of the "ordinary." A pneumatic tyre has a much larger surface of contact with the ground than the old solid tyre of much smaller thickness, a fact which is a disadvantage as regards side-slipping on greasy surfaces. On wet or muddy roads a smooth pneumatic tyre may actually float on a thin film of liquid, whereas the narrow solid tyre would penetrate the film and have actual solid contact with the ground. The non-slipping covers now almost entirely used on roadster bicycles have small projections in the form of continuous or interrupted ridges which are pressed through the thin layer of mud into actual contact with the solid ground.

Influence of Speed on Side-slipping.—The pedals, cranks, and legs of the rider, moving up and down, constitute a couple tending to displace the machine laterally, as shown by the simple experiment of suspending a bicycle with its wheel free from the ground, and turning the cranks quickly. A lateral wobble due to the momentum of the unbalanced weight is set up; in actual riding, the motion of the foot of the tyre is resisted by the side friction, but in conditions favourable to side-slipping it is possible that the action of fast pedalling may often provide the proverbial last straw. A good ankle action, in so far that it reduces the vertical motion of the legs, is favourable to non-slipping. Similarly, free pedals may be in many cases advantageous in this respect. Other things being equal, the long crank with high gear will be better than the short crank in this respect, as the reversals of the vertical motion take place more slowly, and consequently the transverse couple tending to cause side-slip is smaller.

It is a widespread opinion that the actual driving pressure applied to the pedal causes a tendency to side-slip, but provided the body is not shifted laterally I cannot possibly see how the act of pressing on the pedal affects the question one way or the other. The question of side-slip depends entirely on the condition of things at the portion of the tyre in contact with the ground, and any action in any other part of the machine has absolutely no influence on side-slipping, unless it does influence the dynamical conditions at the foot of the tyre. Nearly every new invention in the cycling world is claimed to be a preventative of side-slip, but provided the frames of the machines are all equally rigid under the driving effort, the nature of the driving gear has absolutely no influence on side-slip.

Back-pedalling.—When the machine is running a-head, and pressure is applied to the ascending pedal, the motion is retarded. In this case, although the actual motion is forwards, the effort applied is one that tends to drive the machine backwards; hence the term, "back-pedalling." The other method of re-

tarding the speed is by application of a brake. In order to understand clearly the mechanical and physiological principles underlying these two modes of applying retarding force, it will be necessary to make a short digression on mechanical work. We are all perfectly familiar with the idea of *force* and *effort*, and I will not stop to define the terms. A force acting on a body may accelerate motion, may retard motion, or the body may be at rest under the action of the force.

Mechanical work is defined as the product of force into the distance through which it acts, measured in the direction of the force. If there is no motion there is no work done. If a rope or chain had a heavy weight hung at its end, there is no mechanical work done if there is no motion of the weight up or down. But if the weight be lifted mechanical work is done, and energy must be supplied either by an animal or a motor of some description. If the weight be allowed to descend it will do mechanical work, which may be used to overcome the resistance of a machine. If the up or down motion takes place at uniform speed the *stress* on the rope is exactly the same as if the weight remained at rest. In raising the weight work is said to be done *against* gravity, while during the descent of the weight work is said to be done *by* gravity. Similarly, when a man supports a weight, but does not allow it to ascend or descend, he performs no mechanical work against gravity, if he lifts the weight he does work against gravity, while if he lowers the weight gravity does work upon him. According to this definition Atlas, in supporting the world on his shoulders does no work against gravity. The muscular fatigue will be different in the three cases. If the weight is heavy the man may become fatigued very quickly, but this fatique is independent of work done against gravity. If he raises a moderate weight (for example his own body) through a considerable distance he will soon find his muscles fatigued, while he may lower the same weight through a much greater distance without experiencing fatigue. To come back to the bicycle, when a rider exerts a driving effort on the *falling* pedal, he does work in overcoming the resistances. When he exerts a driving effort on the rising pedal, work is done on him, and although the effort or stress on his legs and muscles may be exactly the same (as was the case in the ascending and descending weight at the end of a rope), the symptoms of fatigue are different. When driving ahead the rider may be said to perform positive work, when back-pedalling negative work. Possibly 99 cyclists out of 100 think that when back-pedalling they are working as hard, and fatiguing themselves quite as much as when driving forward, but I think this is not the case.

Personally, I have back-pedalled down the longest hills I can find, and have not experienced the slightest symptom of fatigue on reaching the bottom. Mental anxiety as to one's personal safety on a dangerous descent must not be confused with muscular fatigue. Another experiment bearing out my contentions as to the essential difference in the physiological effects between positive and negative work is the following:—In the building where my office is situated there is a lift giving a total vertical rise of 84 feet, I have been taken to the top by the lift, run down the stairs to the bottom, again been taken up the lift, and so on for twelve times, giving a total height of about 1,000 feet that I have descended. At the beginning and end of the experiment my pulse was 88 and 112 beats per minute respectively, respiration was 16 per minute both at the beginning and end of the experiment, and at the end of the experiment I did not feel in the slightest degree fatigued. The average time of each descent was 54 seconds, the average time of ascent in the lift 42 seconds. Needless to say if I had attempted to run up the stairs 12 times in succession I should have performed quite a different piece of work. In running downstairs, although the muscles are exerting effort they are doing negative work, as in back-pedalling; whereas in running upstairs they are doing positive work, as in driving ahead.

Conservation of Energy.—One of the doctrines, the truth of which has been most firmly established by experimental research, is that of the "Conservation of energy," which asserts that energy cannot be created or destroyed, although it may be transformed from one kind to another. In pure mechanism, kinetic energy is continually being converted into potential energy, and *vice versa*. A bicycle at rest at the top of a hill possesses no kinetic energy, but possesses potential energy in relation to a level at the bottom of the hill. If the machine be allowed to run freely down hill, when it reaches the bottom its original store of potential energy is converted into kinetic energy due to its speed; this may be again converted into potential energy if the machine be allowed to run up-hill. If the frictional resistance of the mechanism, tyres and air could be entirely

eliminated, it would attain exactly its original height. If a bicycle be allowed to descend a hill at a uniform speed, being kept in check by the application of the brake, the potential energy it loses during its descent is dissipated in the form of heat at the brake-block and the surface on which it rubs.

An electric motor on a tram-car being driven up-hill requires a considerable support of energy from the accumulators or from the power-house. When running down-hill the same motor may be arranged as to act as a dynamo supplying energy to the accumulator or to the power-house. In this case the action of the motor is reversible.

A locomotive will run on a down gradient without any expenditure of steam; if steam be supplied to the cylinders the speed will be increased. If the gradient is steep the speed may become excessive, unless retarding force is applied; this may be done by the brakes, or by reversing the valve-gear of the engine so that the mechanism acts as if the engine were to be driven up-hill. In the latter case, not only is there no steam used, but air is drawn into the cylinder during what would be the exhaust stroke if the engine were actually moving up-hill; this air is compressed to boiler pressure during what would usually be the expansion portion of the stroke, and is forced into the boiler during what would usually be the admission period of the stroke. This action may be inefficient, but, without any special attention to it on the part of the engine designers, there it exists.

Similarly, in the case of the compressed air-motor lifting a weight, if the weight be allowed to descend against the resistance of the motor, either by adjustment of the valve gear, or by slightly overloading, the motor acts as an air-compressor, and stores up energy in the compressed air reservoir.

Thus, nearly all inanimate motors are, to a certain extent, reversible, and extending the term *back-pedalling* to their action when the driving effort applied is opposite to the direction of the actual motion, we see that when back-pedalling they act as energy storers.

Animal Motor Mechanism.—The question arises—What becomes of the energy absorbed by back-pedalling? Is it all dissipated in the muscles in some form that cannot be utilised again in driving up-hill, or is some proportion of the energy stored up in a directly utilisable form? Since in the animal mechanism the muscles are probably quite as efficient as any mechanical motors, it does not seem an unreasonable speculation that the muscle cells are also, to a certain extent, reversible engines. and that when they perform negative work, as in back-pedalling, there is actually energy stored up in them in a utilisable form. I have already referred to back-pedalling down long hills, without fatigue. I will go further, and say that having finished back-pedalling down the steep side of Harrow-hill, I seem to be actually fresher than at the top. A simple experiment, which can be performed by all, would seem to bear out this contention. I can raise and lower myself by bending my legs, fifty times in one minute. The trunk of my body and arms are raised a height slightly over two feet, my thighs probably a distance of about 15 inches, and the lower part of the leg a less distance. My weight is over 11 stone, so that in each upward movement, I perform say 120 lbs. $\times$ 2 ft. $=$ 240 ft.-lbs. of mechanical work against gravity; this repeated fifty times gives 12,000 ft.-lbs. of work per minute. During the descents I perform 12,000 ft.-lbs. of negative work against gravity, or rather gravity performs 12,000 ft.-lbs. of work against the resistance of my muscles. I think it can hardly be asserted that in the operations described I perform 24,000 ft.-lbs. of work per minute, but the probability is that of the 12,000 ft.-lbs. of negative work, a certain proportion, say 25 per cent., is actually stored up in the muscle cells in a form which can be utilised as positive work in the next lift. Thus the total energy to be supplied by the blood to the muscles would correspond to 9,000 ft.-lbs. of work per minute, the remaining 75 per cent. of the negative work being dissipated in some form which cannot be directly utilised.

Numerous mechanical devices have been proposed for storing up the energy of a machine and rider due to the descent of a hill; but from the foregoing arguments, it seems to me not unlikely that in the muscles of our legs we already possess that mechanism. The storage capacity of the muscles may be small, I should not think it greater than that due to lifting one's self to a height of 40-60 feet, but it is large enough, I believe, to afford a rider considerable assistance in conserving his energy at the end of a long run when he is fatigued. Personally, I have always preferred to back-pedal down a hill rather than coast when it is necessary to keep down the speed by the application of the brake. If the down-hill slope, however, be so slight that the application of a brake is not necessary, coasting either with foot-rests or with free pedals is the most

economical; since if no driving or back-pedalling effort be applied to the pedals, a certain amount of work must be expended in moving the legs, this work being dissipated in some form or other. In other words, while during coasting the leg muscles are passively resting, during back-pedalling, I believe, they are actively recuperating.

If there is any appreciable energy storage capacity in the muscles, a racing cyclist, to get the best result out of himself, before commencing a short race say of $\frac{1}{4}$ mile, should be taken on a multicycle or motor cycle, on which he could back-pedal over a distance of about four times that to be raced. A fraction of a second may conceivably be taken off the quarter-mile record by this means. On long-distance grinds, instead of passively resting for 5, 10, or 20 minutes, he should indulge in back-pedalling when he feels fatigued.

It will be gathered from this discussion that the form of free-pedal device that I regard as most satisfactory is one that allows of back-pedalling when the rider wishes. Many two-speed gears allow of back-pedalling in one position of the mechanism, and of free pedals in an intermediate position. The Rambler two-speed gear, which I described last week, is perhaps the best of this type; others on the market at present are the Beaumont and the Bevis two-speed gears.

Brakes.—The variety of brakes at present on the market is tremendous, the most common is the ordinary hand-brake, applied, as the name indicates, by the hand of the rider. In most of the free-pedal machines a brake can be applied when a slight backward motion of the pedals is made. This class has been very excellently named by Mr. Bidlake *pedal-backing brakes*, as distinguished from back-pedalling brakes, which are applied during the ordinary action of back-pedalling, and which supply an auxiliary retarding force in addition to that given by the back-pedalling itself. Pedal-backing brakes may be subdivided into two classes:—In one class a roller clutch is employed, acting in the reverse direction to the free-pedal clutch. When the pedals are moved backwards a slight distance the brake clutch comes into action, and throws the brake mechanism into operation. In the Juhel gear (Fig. 8) the brake clutch is concentric with the free-pedal clutch. In the Wilkinson Sword Company's free pedal machine the brake clutch is on the crank-axle, while in Renouf's free-pedal gear the brake clutch is contained in the hub. With all these arrangements there is usually an adjustment which enables the rider to apply the brake immediately the pedal backing motion is started, or allows any de-

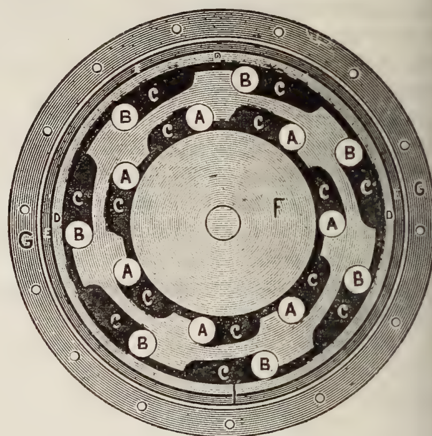


FIG 8.

sired interval to elapse from the beginning of the pedal-backing to the application of the brake.

In the other type of pedal-backing brake the brake is applied by a pawl hit by the crank during the pedal-backing; this pawl moves easily out of the way during the forward driving of the pedal. Thus the brake is applied only in one definite position of the crank, and a considerable backing-pedal movement may sometimes have to be made. The one on the table made by the Cycle Components Company and supplied with the Ariel free-pedal machine is an example of this class. The application of the pedal-backing brake at one point of the revolution of the crank-axle or at *any* point is a subject that is exciting a considerable amount of discussion in cycling circles at present.

Retarding Force.—The retarding force required to neutralise a gradient, *i.e.*, to prevent the speed increasing, is found by multiplying the total weight of machine and rider by the gradient, expressed in the usual way as a fraction or ratio of the vertical rise to length of road. Thus on the gradient of 1 in 12, a retarding force of $\frac{1}{12}$ W is required. To bring the machine to rest from a speed V miles per hour on the level, within a distance of D feet, requires a retarding force $= \frac{V^2}{30\,D}$ W. To pull up on a down gradient requires a retarding force—

$$\left(g + \frac{V^2}{30\,D}\right) \text{W}.$$

Speeds from 20 to 30 miles per hour are met with when coasting down a steep hill, and when the traffic and the nature of the road permit, the expert cyclist enjoys the sensations of the quick rush through the air. At these high speeds a very powerful brake is necessary for safety.

Tyre, Rim, and Hub Brakes.—Most bicycle brakes have been applied to the tyre, but many of the common tyre brakes are utterly insufficient to keep the machine under control on a steep hill. Within the last few years rim brakes have become more popular, the Linley front-wheel and the Bowden back-wheel being two of the most successful. The possibility of the brake damaging the tyre has, in my opinion, been over-estimated. The rim brake is cleaner than the tyre brake, and is generally regarded as the more powerful. However, by far the most powerful brake I have tried is a rim brake used by the Gormully and Jeffery Manufacturing Company on the Rambler bicycles. To produce a certain retarding force on the machine, the force required at the brake block is inversely proportional to the speed of the part on which it rubs. From this point of view a tyre brake is slightly better than a rim brake, the latter is much better than a hub brake, and a hub brake is, in turn, much better than a crank-axle brake.

Front v. *Back-wheel Brakes.*—When a retarding force, R, is applied to a bicycle, either by a brake or back-pedalling, the vertical load on the front wheel is increased, that on the back wheel decreased by an amount $\frac{h\,R}{b}$, h being the height of the mass-centre of machine and rider above the ground, and b being the length of wheel-base. If w_1 and w_2 be the vertical loads on the front and back wheels respectively when the bicycle is running at uniform speed, the vertical loads during the application of the retarding force R, are respectively $\left(w_1 + \frac{h}{b}R\right)$ and $\left(w_2 - \frac{h}{b}R\right)$.

The greatest possible retarding force R′ will be when the wheel to which it is applied is just on the point of skidding, and will be u times the vertical load on that wheel, u being the co-efficient of friction of the tyre on the ground. Thus for a front-wheel brake—

$$R' = u\left(w_1 + \frac{h}{b}R'\right) \quad \text{or} \quad R' = \frac{u\,b\,w_1}{b - u\,h}$$

For a back-wheel brake—

$$R' = u\left(w_2 - \frac{h}{b}R'\right) \quad \text{or} \quad R' = \frac{u\,b\,w_2}{b + u\,h}$$

In a single bicycle, as an example, w may be taken $\frac{1}{3}$ W, $w_2 = \frac{2}{3}$ W, $u = {}^2/_3$ $h = 36''$, $b = 44''$; then for a front-wheel brake the greatest possible retarding force is R′ = ·49 W; for a back-wheel brake, R′ = ·29 W. If the road is not absolutely dry, u may be less, say $\frac{1}{3}$, in which case, for a front-wheel brake, R′ = ·15W, for a back-wheel brake, R′ = ·18 W. Thus, when it is a question of pulling up in the shortest possible space, the front wheel is the best place for the brake. But under usual touring conditions this emergency seldom occurs, and it may be said that an effective brake can be applied either to the front or to the back wheel.

The straining action put on the front-fork and steering-tube is sometimes urged as an objection to the front-wheel brake. But when running at uniform speed, the stress on the front-fork is such that the front wheel tends to get further away from the back wheel. The stress introduced by the application of the brake, tends to bring the front-wheel near the back-wheel, in other words, it is a stress of opposite algebraic sign. Up to a certain point, therefore, the application of the front-wheel brake *diminishes* the stress on the front-fork and steering-tube. This can easily be verified by a simple experiment. Riding at uniform speed on level ground with the steering head a trifle loose, the upward reaction on the front wheel keeps the steering-tube pressed up against the near side of the top row of balls; on applying the brake gradually, the steering-tube can be made to shake between the top row of balls, while a further application of the brake presses the steering-tube steadily against the front side of the row of balls. I have put a Rambler bicycle, with the powerful brake above referred to, to most severe tests by putting on the full power of the brake, but could detect no sign of injury to it.

Saddles.

Time will not permit of much being said about saddles, which is perhaps no great loss, as the question of a suitable saddle is essentially a personal one; what may give great comfort to one may give absolute misery to another rider. As regards the amount of spring to be given to a saddle, this should be sufficient to allow the leg motion to take place with freedom and comfort. Any greater yield of the saddle beyond that necessary for this purpose may be a direct loss of energy: the mechanical principles involved being somewhat of the same nature as those discussed

with reference to the tyres. I will confine myself to a reference to the Esmond saddle, in which there is little or no resistance to the saddle swaying sideways as the legs move up and down. There should be less loss of energy in this saddle than in those constructed with stiff springs which are continually extending and contracting.

Miscellaneous.

*THE OCCURRENCE OF DIAMONDS IN NEW SOUTH WALES.**

There can be no doubt that, sooner or later, as our diamantiferous areas become more thoroughly exploited and developed, and with the advent of more favourable seasons, the diamond-mining industry in this colony is destined to become one of magnitude and importance.

The occurrence of diamonds in New South Wales was recorded by Stutchbury (on the Turon River), and by Hargraves (at Reedy Creek, near Bathurst), as early as 1851. In 1859, the Rev. W. B. Clarke reported their occurrence at Burrendong and at Pyramid Creek, while a year later he also stated them to have been found at Calabash and at Suttor's Bar, Macquarie River. Since then diamonds, in single specimens, have been recorded in many widely separated portions of New South Wales; they have likewise been found in Victoria—chiefly Gippsland—while the late Dr. J. J. Bleasdale reported their discovery at the Echunga diggings in South Australia.

In 1867 they were found to occur at the Cudgegong River (Mudgee), at which place, during that year, between 3,000 and 4,000 diamonds were won from the claims of the Australian Diamond Mining Co., Messrs. Scott and Allen, and Messrs. Cooney and party. In 1872-73 a somewhat extensive rush took place to Bingera, where a large number of mineral leases were applied for, and it was anticipated that diamond-washing would become a permanent and paying industry. Unfortunately, however, the stones being small, and the Sydney jewellers declining to buy, there was no outlet, and the work was suddenly abandoned. In 1881 the Bingera field was visited and examined by Mr. Geological-Surveyor E. F. Pittmann (now Government Geologist), and the result of his investigations was furnished in a report by him published in the Annual Report for that year. Following this report, renewed interest and attention seems to have been paid to that locality, and since 1883 mining of a more or less desultory and spasmodic character has been conducted there—the scarcity of water experienced in the district, having greatly retarded operations both in that and later years. In 1883-84 diamonds were found in the Tingha Division near the Big River, Auburn Vale, and here also the industry has since been prosecuted in a small way.

Owing to the great difficulty experienced by miners in finding a ready market for their diamonds advantage was taken in 1886 of the exhibit of New South Wales diamonds of the Colonial and Indian Exhibition (a collection of which had been purchased by the Government, in 1885, for that purpose) to obtain, through the Agent-General, some information concerning the prospect of a market in London for the products of our mines. The exhibit referred to having been carefully examined by Messrs. Thomas Davies, F.G.S., and R. Etheridge, jun. (several of the gems having been cut and polished by Messrs. Ford and Wright, of London) a lengthy and interesting report was furnished by them. The following conclusions, among others, were specially emphasised:—1. That the diamonds of New South Wales in their physical characteristics are more nearly allied to those of Brazil than any other country. 2. They have been largely sold in London as such. 3. As regards colour, they differ practically but little from those of other fields. 4. The general absence of "cleavage" and "macles" is a point in their favour. And 5. That the greater hardness of the New South Wales gems would probably raise the cost of cutting, but this would be compensated for by their extra "brilliancy." Indeed, as a matter of fact, in brilliancy and refractive power the New South Wales gems surpass the African, and one of those cut in London, by the firm above alluded to, was stated to have been as fine a brilliant as it was possible to obtain in any part of the world.

The principal diamantiferous deposits in this colony occur in outliers of Tertiary river drifts and cement representing old river accumulations, of more than one geological age, lying at various distances from present river channels, and once forming portions of widespread and continuous deposits resting on the bedrock of the country. They also occur in the more recent drifts derived from them.

There has been a great diversity of opinion as to their origin and true matrix, and several theories have been advanced, but the question still remains in abeyance. The late Mr. Norman Taylor believed them to have been chemically formed in the older Tertiary drifts; and, in support of this view, adduced what at first sight might appear very cogent reasons. The late Mr. C. S. Wilkinson held the same view at one time; but after an extended examination of the diamantiferous deposits in the Northern District, he suggested that if the Tertiary drifts be not the original matrix of the diamond, possibly its source may be in the metamorphosed Carboniferous or Devonian beds, where they have been intruded by granite or porphyry. Professor David came to the conclusion that the Cope's Creek diamonds were probably derived from the tourmaline granite. It is, however, now believed that their source will ultimately be traced to volcanic "pipes" analogous to

* A Report by D. C. McLachlan, Under-Secretary for Mines and Agriculture, Sydney, N.S.W.

hose found in the celebrated Kimberley Field of South Africa. Whether or not this solution will prove correct, time alone can determine—certainly up to the present there is no evidence of any such "pipe" having yet been found. But, as pointed out a few years ago by the present Government Geologist, Mr. E. F. Pittman, even presuming the existence of such "pipes," the probabilities are, unfortunately for the prospector, that their ancient surface outcrops lie effectually concealed beneath the basalt flows, which to such a considerable extent cover the diamantiferous areas.

In 1894, in consequence of statements which had been made to the effect that such a volcanic "pipe" had been discovered at Bingera, Mr. Geologist-Surveyor Stonier was instructed to make an inspection and report. Mr. Stonier spent several months in examining the field, but found no evidence to warrant the statements made. Again, so recently as June, 1897, in compliance with a petition from the residents of Bingera for a specific report upon a volcanic "pipe" alleged to have been discovered in the Australian Diamond Company's Mine, Mr. Geologist-Surveyor J. B. Jaquet was deputed to inspect and report upon the so-called "pipe." Samples of the rock, stated to be volcanic breccia, had previously been forwarded to the Department by Mr. Wingate, the manager of the mine, and, upon examination, the Government Geologist had pronounced them to be of sedimentary origin. The result of Mr. Jaquet's examination locally, was to completely bear out the opinion which had been expressed by the Government Geologist. The so-called breccia proved to be Carboniferous claystone, which is the prevailing rock underlying the diamantiferous river drifts of Bingera.

The diamonds found in this colony generally average from 5 to 6 to the carat, although gems of 2–2½ carats are occasionally found, and one of 5⅜ carats has been recorded. The number obtained per load varies very greatly; the Round Mount Co. (Cope's Creek, Inverell) in 1886 washed 722 loads for 2,685 carats—from 6 loads obtaining the exceptional yield of 1,080 diamonds, weighing 296 carats, which probably establishes a record so far as our fields are concerned.

Very great difficulty is experienced in procuring accurate and reliable information as to the quantity and value of the gems which, up to the present, have been won, especially as regards the earlier years of the industry.

It is a significant fact that, in spite of the severe drought, with its attendant drawbacks, the output for last year—16,493 carats—is, in quantity though not in value, the largest recorded since the opening of the industry. The Boggy Camp Diamond and Tin Field yielded 14,920 carats of diamonds during the year, valued at £5,625, the gems being associated with tin in considerable quantities. This field has been considerably developed during the year, but work was greatly hampered through the scarcity of water. There are indications that this field will now be thoroughly tested, as capital has been attracted to it. The next diamond field of importance is situated about six miles from Bingera. This field has been practically idle during the year, owing to the water difficulty, the only work being done by Captain Rogers in the "Monte Cristo" Mine, from which 1,573 carats were won. As soon as rain falls, work will be started by several large companies, and it is expected to prove highly successful.

Considerable interest has lately been centred in these fields, and as some indication of the progress of the Northern District, generally, a local "Mining Exchange" has recently been opened at Inverell—the only one established in any part of the colony outside the capital, with the exception of Brokenhill. Indeed at the present moment there are not wanting signs of a large and progressive development of the field.

ACETYLENE GAS GENERATORS.

At the Congress in connection with the Acetylene Exhibition held at Budapest last May Dr. Ludwig read a paper on gas generators, which is thus reported in the *Engineer*. He gave an account of the progress that had been made in the construction of gas generators during the past year. After a brief but courteous acknowledgment of the huge debt which generator manufacturers, in Germany, as in this country, owe to Professor Lewes, for his careful experiments on the theory and practice of acetylene production, he began by dealing with carbide-to-water apparatus. Ludwig remarked that the mechanism employed to feed the carbide as reqnired into the water had been greatly simplified, and in most recent forms was fairly trustworthy; but as it was usually driven by the rise and fall of the holder-bell, this method of procedure had the defect of throwing considerable and undesirable work on the gasholder, which work, moreover, was apt to vary as the general store of carbide decreased in weight. Carbide-to-water generators were therefore more suited for hand charging, and as such were indicated primarily for installations where a man would be in constant attendance. It will be within the recollection of most readers that Professor Lewes has stated that the output of gas per unit weight of carbide in apparatus of this type rarely exceeds 84 per cent. of the proper amount—a loss which he ascribed partly to imperfect decomposition of the carbide and partly to dissolution of the acetylene in the large excess of water. Unfortunately he has not given any estimate of the relative magnitude of these defects: but it seems clear that, by proper construction of the generator, imperfect decomposition should be capable of almost complete elimination, for the usual source of this trouble depends on the fact that some of the smaller fragments of carbide fall through the false bottom—when one is fitted—and become coated with a resistant layer of lime sludge. Ludwig did not mention this latter objection, possibly because he considered it had already been overcome in the goods

of the best makers; but referring to the loss of acetylene due to dissolution, he stated that a carbide-to-water generator would work with one gallon of water per 2 lb. of carbide—a volume which could only absorb 2 per cent. of the acetylene, assuming the theoretical yield to be 5 ft. per pound. On the large scale the lime sludge might be drawn off, the solid matter allowed to settle, and the liquid returned to the generator, thus decreasing the waste of gas; in smaller apparatus it would be more convenient and cheaper to bear with the loss. Another trouble met with in these generators was the foaming that occurred with certain brands of carbide; and he suggested that this was caused by the use of a material containing aluminium. Aluminium carbide evolves methane on treatment with water; and methane in lime water, he said, always foamed. Experiments with oils, salts, &c., instituted to discover a means of avoiding the difficulty, gave negative results.

Among water-to-carbide generators, improvements had been even more pronounced. When the total charge of carbide contained in the apparatus was distributed among a large number of small compartments, and the water was admitted in such fashion that it could only reach one portion at a time; and when the quantity of water admitted each time some entered the decomposing chamber was more than sufficient wholly to decompose each portion of the carbide, then water-to carbide machines worked quite as well as those of the opposite construction. The system of permitting water to fall either in drops or as a stream on a mass of carbide was being abandoned; for apparatus of this design were specially liable to excessive heating accompanied by the inevitable decomposition of part of the acetylene, while they also had the defect of leaving some of the carbide unattacked. This incomplete reaction was not merely wasteful but was actually likely to prove dangerous if the residues were dealt with carelessly. However, generators of this type, in which the carbide was subdivided into small portions like those previously described, were still being manufactured, and it remained to be seen how they would compete with their rivals. In short, Ludwig's remarks only bear out those made by other observers, viz., that to obtain satisfactory generation, to avoid excessive heating and consequent polymerisation, water must always be in excess at the time and place of actual chemical reaction between the two substances.

Ludwig considered that portable lamps had been improved, but were still far from perfect; that methods of purification were satisfactory, and that if they were employed burner troubles would no longer exist. Purification with liquids ensured greater regularity of action than when the same reagents were used as solids, but the former method involved more loss of pressure. When the gas was to be dried again after purification lime was better than carbide, but precautions must be taken to prevent dust passing into the pipes. In connection with this latter opinion, it may be remarked that a highly purified acetylene has practically little odour, whereas an evil-smelling gas is—remarkable though it sounds—advantageous in view of the fact that leaks are more safely detected by the nose than by a disastrous explosion. If the pure but damp acetylene be dried by carbide the gas is scented again, and it would seem the proportion of impurities thus introduced might be sufficient to make it smell without causing it to be objectionable in other respects. This is a matter, perhaps, on which further experience is desirable before a final judgment can be delivered.

General Notes.

Swiney Lectures.—A course of twelve lectures on the "Pleistocene Mammalia," will be delivered by R. H. Traquair, M.D., LL.D., F.R.S., in the Lecture Theatre of the Museum of Practical Geology, Jermyn-street, S.W., on Mondays, Wednesdays, and Fridays, at 5 p.m., beginning Monday, 2nd October, and ending Friday, 27th October. The Swiney Lectures on Geology are under the direction of the Trustees of the British Museum. Admission to the course is free.

Experimental Flax Culture in Mexico.—According to a recent bulletin of the Bureau of the American Republics, it is probable that the growing of flax, for the production of linen, will become one of the industries of Mexico. Experiments were recently made at the National Agricultural School on the outskirts of the City of Mexico, where a plot of ground was sown in flax seed. At the end of sixty-one days, the shoots from these had in some instances reached a height of 41 inches, and gave every indication of taking kindly to the soil and climate, which seems to be well adapted to the cultivation of this plant. The Mexican authorities have become interested in the new venture, and propose to give it every encouragement. The only drawback to this cultivation in the great valley of Mexico, is the lack of water, which, however, can be usually overcome by irrigation. Experiments in flax culture are also being conducted in the State of Flaxcala.

Production of Sesame Oil in Syria.—In the preparation of sesame oil in Syria, the grain is soaked in water for twenty-four hours, and then placed in an oblong pot, coated with cement, on which two men work a wooden hammer of 20 pounds weight. Efforts are made not to mash the kernels. The skins are separated in a tub of water, salted to a degree sufficient to float an egg. The bran sinks, while the kernels remain on the surface. The sesame seeds are now broiled in an oven, and sent to the mill to be ground. From the millstone the oil drops into a jar. It is thick, of a dark yellow colour, and sweet. The product is used extensively by the poorer classes in place of cheese, syrup, honey, &c., and is popular on account of its saccharine properties. Confectionery is made by mixing sesame oil with syrup and other elements. Sesame is widely cultivated in Syria.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in Prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers, and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1900, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

EXAMINATIONS, 1900.

The dates fixed for the Examinations in 1900 are Monday, March 26th; Tuesday, 27th; Wednesday, 28th; and Thursday, 29th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix, containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, W.C.

Miscellaneous.

ARGOLS.

By R. Hedger Wallace.

Argol is a good illustration of what constitutes an agricultural by-product, it being a substance usually found in abundance in the viticultural districts of France, Germany, Italy, and Spain. Argol is simply the mercantile term for crude tartar, and is a by-product of vinous fermentation. It exists in the juice of the grape, and is soluble therein; but during the fermentation of the juice as it passes into wine, alcohol is developed, which, remaining in the fermenting liquor, causes the precipitation of the argol. Some wines, if bottled when not fully ripe, develop more alcohol on keeping, and a further precipitation of argol therefore takes place, recognisable as a crust in the bottom: hence the meaning of the term "crusted port." This substance forms a crystalline deposit or crust on the inside—bottom and sides—of wooden casks, vats, or tubs in which vinous fermentation takes place. It is, however, only deposited during such fermentation, never afterwards. When the wine is drawn off, this deposit is scraped from the inside, and the crust becomes hard, brilliant, and brittle, and is readily reduced to powder. The crystals are white or slightly coloured, according to the character of the wine in which they are deposited. That which is found in barrels having contained white wine is of a dark cream colour, while that extracted from red wine barrels has a pinkish tinge. The argol deposited by white wine contains fewer impurities than the other, but when refined both are identical. The quantity found also varies according to the quality of the wine. The white wine gives less than the red, the strong more than the light wine. Locality, apparently, also affects production. It is said that the meridional provinces in Italy yield more argols than any other part of that country; and wine-growers in the Pfalz, the area lying west of the River Rhine, state that wine made from grapes grown upon the northern slopes of the ridges and hills yield more argol than wine made from fruit grown on the southern or sunny slopes. In France, the wine producing the largest quantities of argol are those of the extreme south, and the trade in it is consequently limited almost entirely to the regions about Marseilles, Bordeaux, and Lyons. It is well known that, in many instances, it becomes necessary for the viticulturist or wine merchant to clarify the product of the vineyard by treating it either with gypsum or the white of eggs. Wine clarified by gypsum is richer in argol than that which it has not been found necessary to treat in this manner, while clarets cleared by the albumen of eggs are said to produce an argol which yields an exceptionally superior quality of cream of tartar. The most important argol-producing localities in Europe, let us add, are the districts adjacent to Messina, Naples, Palermo, Bordeaux, Lyons, Marseilles,

Lisbon, Barcelona, and Tarragona, all of which are viticultural centres.

Though we recognise argol, or crude tartar, to be a collateral product of wine, yet the fact that it is formed only by wine which has reposed in wooden casks proves it to be a product as recent in origin as are wine casks themselves. Ancient Greeks and Romans knew not the value of casks, for they kept the fermented juice of their grapes in great earthen vessels, very much like those employed to-day in certain parts of Spain. Any one who has travelled in the Iberian peninsula will recall the fact that wine there is often kept in goatskins, stone cisterns, and other strange vessels made of hides and clay. In these receivers argols, or crude tartar, have never been known to form, yet the wines of Spain are rich in the article. In recent years, however, the Castilian viticulturist has almost exclusively employed for storage wooden casks, for the purpose of collecting this valuable sediment, and adjunct to the income from wine-making.

The value of tartar as a medicine is said to have been first discovered by Paracelsus, the celebrated Swiss astrologer, alchemist, and professor of medicine at Basle, who was born at the end of the 15th century. He stated that it was composed of oil, water, and salt, an analysis which is as inaccurate as the same scientist's analysis of the human body, which, according to him, was made up principally of sulphur and mercury. The real composition of argol was, however, determined in 1770 by the celebrated Pomeranian chemist, Scheele, the discoverer of chlorine, who found its active principles to be composed chiefly of bitartrate of potash along with a small portion of tartrate of lime. Argol, then, may be regarded as crude potassium bitartrate, and from it is produced cream of tartar, tartaric acid, tartar emetic, potassium carbonate, blackflux, pearl ash, baking powders, and mordants for fixing colours in dyeing.

An ordinary French wine barrel yields from one to two pounds of argol, or wine lees, which the viticulculturist sells to the tartar manufacturer, who either disposes of it in its crude form or refines it into cream of tartar. In some instances, however, these wine dregs, instead of being used in the manufacture of cream of tartar, are employed by brandy merchants to impart a fruity flavour to newly distilled spirits, very much in the same manner as burnt sugar and prune juice are employed in the United States to colour and sweeten whiskey. This much can certainly be said for such a use of wine dregs as noted above, that it is a perfectly innocuous and wholesome essence of the product of the vineyard, and in fact it is based on the theory common to the viticultural districts of France, namely, that the solidified lees of old wine improves the quality of the new. So strong is the feeling as to the valuable quality of the lees, that it is frequently the case that dealers in argols find it difficult to purchase this product except where barrels are broken to pieces as being no longer suitable for storage purposes.

A special collective consular report on the production of argols in Europe has lately been issued by the United States Department of State, and from this volume we note some of the processes of preparation and the preparations made from argol in France, Germany, Italy, and Spain. The process of preparing tartar for commercial purposes in France is not only very simple, but inexpensive. The crude product is generally taken from barrels in which wine has lain for three or four years, that being the average period the liquid is left in the cask previous to bottling. Of course the longer the wine remains in the barrel the better and more abundant will be the lees. About 30 per cent. of these settlings is crude tartar. The wine being drawn off, the sediment is removed in a crust, usually detaching itself in irregular cakes of about four inches square in extent, and half an inch in thickness. These cakes are allowed to dry, after which they are triturated, either by hand or machinery, until they resemble very fine gravel or sand. In this form it is sold to the manufacturer, who boils it in water for two or three hours until it is entirely dissolved. The solution thus made is then drawn off into shallow metal or earthenware receivers, upon the bottom and sides of which the tartar forms as it cools a mass of crystals. The liquid that remains is boiled and cooled over and over again, until evaporation is complete, and nothing but crystals are left. Purified tartar becomes cream of tartar, or bitartrate of potash, forming a white odourless crystal of an acrid taste. There are two varieties of cream of tartar made in France, the *crême de tartre de Montpellier*, sold in irregular cake-like crusts, and the *crême de tartre de Marseille*, in smaller cakes. The Montpellier tartar is made by boiling crude tartar in water with animal charcoal and clay; these substances form a white scum, which is taken off and allowed to crystallise, the crystals being subsequently washed in cold water and dried. The pure tartaric acid is then isolated from its acid potash by what is known as "Scheele's process." The processes by which various tartrates and other combinations of tartar are derived from argols are technical and chemical, and much too intricate to be mentioned here.

Argol was extensively used in former years by dyers as a mordant, that is to say, as an intermediate substance, which having a strong affinity for both organic fibres and colouring matter, becomes a bond of union between the two, making thereby a fast colour. The reactions or combinations formed, when used as a mordant, were tartrate of alumina and tartrate of tin. In Germany, argol in former years was much used when woollen goods were dyed, but since the introduction of aniline colours it has lost its value as an article of commerce in this industry. Still, however, the principal market for argols from white moselle is the chemical and cloth factories of Germany, and quite a quantity of tartaric acid is converted into dioxy-tartaric acid, and used in the manufacture of a yellow colouring matter for wool, known as tartrazine. The chief countries which import

argol or tartar are England and the United States, but the shipments to the latter country are exceptionally large, it taking more than double the quantity shipped to all the other countries combined, owing to the fact that it is there used on a very large scale in the manufacture of baking powder, a purpose for which it is not so universally employed elsewhere. The extent to which tartar is used in combination with food products would, it is stated, be perhaps "most easily ascertained from the export books of the numerous baking powder firms of the United States, unless the relative prevalence of dyspepsia in various countries should be deemed a sufficient answer." Such an inquiry, however, does not come within the scope of this article.

Before proceeding to note some interesting facts regarding the production of argols in Germany, Italy, and Spain, we would state that in some countries only the crust of crude tartar attached to the sides of the cask is termed argol, while the sediment adhering to the bottom is designated lees. In this article, however, we use the term argol to include any natural product obtained in the process of wine making which contains tartar. Turning to Germany, we find that there, besides argol (called *weinstein* in German) from wine, there are also what may be termed "husk wine argols" and "mud argols." What is known as "husk wine argols" is obtained from the skins and pulp of the grape remaining after the husk brandy has been extracted, and is produced in the following manner. The husks, &c., which are found in the boiling vats are emptied into a wine press, and all the liquid remaining is pressed out. This is again boiled and drawn off into barrels and cooled with ice-water. In from eight to ten days the argol contained in the liquid crystallises out, and after the water has been withdrawn it is taken from the sides and ends of the barrels. An inferior quality of argol is obtained by not boiling the liquid pressed out, and simply allowing the argols, by what may be termed a natural process, to precipitate out. This is what is known as "mud argols." Some distillers, after having pressed the grapes and secured the brandy, do not boil a second time, as noted above, but allow the extract to run direct into casks or barrels in which birchwood twigs have been placed, and to these, on precipitation, the argols adhere. In casks made of chestnut wood it is said no argol (wine stone) will be formed. In whatever way the crude argol be obtained it is disposed of to the "Weinsteinfabriken," where it is converted into various preparations of tartaric acid, such as cream of tartar, seignette salt, tartar emetic, potassium carbonate, black flux, and pearl ash. The by-products of the Weinsteinfabriken are disposed of to manufacturers of fertilising materials.

As was to be expected, a large quantity of argol is produced in Italy. The collections from vats, &c., in that country, are taken to local markets and sold to "tartarari" or tartar men. When a considerable quantity is received, these "tartarari" dispose of their bulks to still larger dealers in more important centres, and these to large wholesale houses. According to the process of making employed, the article is placed upon the market in five varieties, as follows:—*Feccia asciutta* (dry lees), the name for the lees left behind in the vat after the wine is drawn off for the first time. Then *tartaro crudo* (crude tartar), that is the sediment coating the interior of vats which have been used for a long time. Next comes *cremore di vinaccia* (cream of wine dregs), and it is obtained in the process of obtaining alcohol from the grape skins; the water used in distilling the alcohol is poured into receptacles filled with birch-broom, on which the *cremore di vinaccia* crystallises out. The remainder of the fluid, which does not crystallise on the birch, forms a dense acid sediment, which, after being pressed and dried, is put on the market under the name of *limo di cremore* (deposit of cream). The last form, known as *cremore di seccia*, is obtained when the fresh dregs of wine are boiled in water, and the fluid poured into vats in which the argol crystallises out in the usual manner, as the *tartaro crudo*.

The processes for extracting argols in Spain are three in number, and are very simple. In making wine, the grapes are gathered in large baskets and placed in a vat, which is generally located in a specially constructed outhouse. They are here trodden upon by barefooted peasants, and the juice passes through holes in the bottom of the vat into a tank. When all the juice has been extracted, it is customary to open the bottom of the vat, and to let the grape skins fall down into the juice, and remain there fermenting for six or eight days, in order that the wine may become more highly coloured. At the end of the fermenting period the juice is drawn off and put in barrels, and the grape skins are put into presses, which extract the juice that remains, and this is also put into the same kind of barrels. What remains in the presses are then taken to factories, where alcohol is obtained from it. After this process is concluded vine shoots are placed in the hot liquid residue left, and as the liquid cools argol gathers about the shoots, from which it is, in due course, scraped. It is then dried and whitened by various methods, all of which are considered secret. The argol so produced by this process is, however, of the lowest quality, and is the least valuable.

The juice that was taken from the vat and put in barrels is generally kept from 15 to 20 days, when it is carefully taken out and the lees are sold to wine brokers, who at once extract what wine still remains and then dry the rest and sell it to the tartar factories, in which it is prepared for the market. This kind of argol is ranked as tartar of the second class.

The best tartar is obtained from wine that is withdrawn from the vat and kept in one set of barrels for five years or more, and in the inside of which it crystallises out. When this is finally taken out, it is dried and sold to the factories. The drier the nature of the wine, the more argol it produces. The principal market for tartar in Spain is Barcelona, and there is apparently a large home demand, it

being principally used as a diuretic, refrigerant laxative, and cathartic, and in bread-making.

What has been said as to extracting argols from wine applies also to the extracting of argols from pomace or crushed apples, and it is often so extracted in districts where cider is made. The production of argol or tartar, it must be borne in mind, does not constitute an actual industry in itself, but is only an accessory to wine and cider-making, and may be therefore regarded as a supplementary agricultural industry. Further, it is apparent that the only precess for extracting it is a natural one, and it is so simple that it can be undertaken by anyone. Next to the United States, England is the heaviest importer of crude tartar. As we have no vineyards, with one solitary experimental exception, in this country, the production of argols should be taken up by our wine-producing colonies. It is not a high-priced product, but it is a source of profit, as all waste products are when utilised.

LUXEMBURG KID GLOVE MANUFACTURE.

Whereas what is called "chamois" leather is really a sheep's skin split into halves, kid gloves are actually made from the skin of a kid, except that lamb skins are also used, especially for the stronger qualities. The younger the kid, the thinner, finer, and softer will naturally be its skin; and such skins are used for the best-quality gloves, being lighter to manipulate although requiring more care, while the workmanship is the same for all qualities.

Kid skins are obtained from Germany, Austria, Sweden, Brazil, Madagascar, and lately from Cyprus, but more especially from France and Bavaria. Russia and Arabia supply a great many lamb skins, which are larger, thicker and stronger than kid skins, being, consequently, more difficult to work; but they have the advantage of being less liable to tear in the process of manufacture. There is, however, no apparent difference between lamb skins and kid skins; and none but an expert can distinguish between gloves made from the two. As a rule it is the natural outside of the skin which also comes outside in the glove; but in what are called Suède gloves, just the reverse is the case. This trade appellation originated through Swedish kid gloves having always been made with the inside of the skin kept outside in the glove. It will be remembered that dark and even black gloves are white inside; and, to preserve this whiteness, special treatment is required, as will be referred to more particularly below. It will perhaps come as a surprise to many to learn that each glove is composed of 15 to 19 pieces, irrespective of the fastening, and also that it passes through from 100 to 160 hands before being packed, each pair separately in tissue paper, and then a dozen pairs together, in a band of yellow paper, ready for delivery.

June is the season for taking in the stock of skins, which are, for the most part, yielded by year-old kids; and the skins are generally kept in stock for about a year before being worked up. For storing, the skins are packed with naphthaline, in order to kill an insect known as the "Acosti," which would otherwise attack the skins, and render them practically worthless. The larger skins are picked out for making the long gloves known as "mousquetaires," of which only a single pair can be obtained from one skin; but for ordinary gloves, taking one size with another, it may be stated that about two pairs can be got out of a single skin with careful planning. The glove manufacture comprises three distinct processes, viz., dressing, dyeing, and the actual glove-making.

DRESSING.

As many skins as can be dressed in a day are brought out of the storehouse, and first soaked in clean water for two days, the water being changed on the second day; but the thicker lamb skins are soaked for three days. The object of this soaking is to restore the original suppleness of the skins, because it is rarely possible to dress them directly they are removed from the animals, The skins are then immersed, first in a weak and afterwards in a strong, solution of lime and sodium sulphide, contained in pits excavated in the ground and lined with cement. This soaking is continued for two days in the weak, and from seven to ten in the strong solution, each of these baths serving for about 12,000 skins before being renewed. The solution does not attack the skin itself, but it kills the roots of the hair, so that what does not fall off of itself in the pits is easily removed by scraping.

The wool of lamb skins is more difficult to loosen than the hair of kid skins, so that different treatment is required in their case. Instead of their being immersed in a solution, the inside, or flesh side, of the skin is spread over by a bass broom with a paste of the same composition as the solution, but naturally more concentrated, and having the consistency of treacle. After being thus plastered, the lamb skins are folded with the wool inside, stacked, and held down by boards, weighted with stones, in the *Mégisserie* department, where they are left from nine to fourteen days. As the paste would attack the hands, the men wear india-rubber gloves. Whichever be the treatment, however, all the skins are rinsed in clean water—the lamb skins in a running stream—before being given out for the subsequent operations.

The hairing is performed by hand on what resembles a gymnasium horse, one end of which, however, rests on the floor, while the other is supported so as to present an angle of about 40°. The man takes his stand at the raised end, having in front of him a board pivoted near the floor, by means of which board, through pressing against it with his knee, he can clip one corner of the skin, thus holding it fast, so as to be able to scrape off the hair with a blunt and curved knife having two handles, which he works over the skin downwards along the slope, changing the position of the skin as required. The

hair, both that left in the pits and that removed on the horse, is kept in separate parcels, as white, black, and mixed. After being washed mechanically, the hair is dried, first by centrifugal force, and afterwards by heat, when it is sold for making hair-cloth or mattresses; but the wool from lamb skins is used for making felt.

After the skin has been deprived of all its hair, it is trimmed on the same horse, by the head, paws, and tail parts being cut off. For fleshing, the skin is turned inside upwards, being fastened by one corner in the same manner as before, and all the fleshy particles adhering to it are scraped off by an appropriate knife. For graining, the skin is again reversed, and pressed out—still upon the horse—in all directions by a special tool in the nature of a scraper, for squeezing out all the adipose matter contained in the pores. When it has been ascertained by inspection that these several operations have been well performed, the skins, a thousand together, are churned with water for about 20 minutes in a cubical box, about 10 feet diagonally between the opposite corners, to which pivots are fixed for turning on a horizontal axis.

The thousand skins are then soaked in a bran bath, heated to 25° Cent. (77° Fahr.), for three hours, after which they are placed in a barrel-churn revolving on a horizontal axis, with internal wooden projections, and containing a solution of alum and sodium chloride. After the churn has been turned for half an hour, 100 lb. of flour and the yolks of about 300 eggs from China are introduced, when the operation is continued for an hour. On the skins being taken out of the churn, each one is folded with the grain (or what was the hair side) inwards, and dried on the first floor of the drying room, at a temperature of about 40° Cent. (104° Fahr.); but in warm weather the skins are dried in the sun on the roof of the drying-shed. When the skins are perfectly dry, they are dipped in water, and then hammered mechanically by what are termed "fullering stocks," to take off the stiffness, after which they are opened, and drawn out in all directions on a semi-circular *pâlisson*, or "staking knife" as it is called. Two skins are then tied together by one corner of each, and hung over a pole to dry; and, when dry, a few are crumpled up together and stamped upon by men with bare feet. The skins are then pulled out from corner to corner, and stretched over a staking knife, sharper than that mentioned above, being scraped at the same time. In the case of the larger and tougher lamb skins, this operation of drawing out requires far more force than with the smaller and thinner kid skins, so that the men engaged in it often suffer in their hands and knees, while also becoming humpbacked. Here, accordingly, is a case in which a mechanical appliance that would perform the operation as well as hand work should be warmly welcomed; but it must be added that no such appliance yet tried has performed the operation in less time and without tearing the skins. The skins are finally piled in bundles of 36, folded all together, and then stored for a period of from six months to two years, in order to be seasoned and rendered fit for the next process, viz.:—

Dyeing.

The tints most in vogue for gloves, viz., black, white, and tan colour, are almost entirely due to a combination of blue, red, and yellow. The dye substances for producing these latter are Campeachy wood (*Lignum campechianum*), producing hæmatein, for blue; Fernamboko wood (*Cæsalpinia Brasiliensis*), producing brazilin, for red; and Fustet wood (*Rhus cotinus*), producing fustin, for yellow. The black dye is formed by combining all three of these substances, in certain proportions, with sulphate of iron, and that for tan gloves by mixing campeachy with fernamboko, while gloves of a white tint are cut from undyed skins, the smoothest being chosen for such gloves. For those to be dyed light shades, however, skins must be selected perfectly free from blemish on the grain side; and, whichever dyeing process be adopted, the skins are previously stamped by men with bare feet in a solution of egg-yolk and water. No mordant is required for dyeing light shades; but the skins are dipped in the dye, both sides being thus coloured equally or nearly so, while skins to be dyed dark tints, instead of being dipped, are (as referred to at the beginning of this article) painted, as it were, on the outside with urine, of which the ammonium carbonate acts as a mordant. It may here be mentioned that although a great many substitutes for urine have been proposed, it has never been found possible to secure their adoption by the men.

The number of skins required to execute an order for gloves of a certain colour, tint, or shade, except very light shades, are given out to one or more dyers, according to the importance of the order; and the dyer takes each one separately out of the water-tub under his bench and places it wet, the inside downwards, on a zinc slab, which is formed like a double desk, with a ridge in the middle, for favouring the off-flow of liquid. The skin is then pressed close to the slab by pushing over it a kind of wooden scraper from the centre line to the outside, in order to prevent the mordant, and afterwards the dye, from penetrating to the inside, which must be kept white. The mordant is first applied by an ordinary scrubbing-brush, being swilled off with water; and the required dye is then laid on with a brush in the same manner, the number of coats, that follow one another immediately, depending upon the depth of shade required.

As each skin is dyed it is hung over a pole, the first skin being placed with the inside undermost, and the others on the top of it in alternate order, so that the coloured sides of two skins always come together. When a few skins are thus collected, they are removed by a boy to similar poles in the cage of a lift, by which they are taken up to the drying-room for dyed skins, where they are hung up separately from hooks by two of their corners, being left

from three to four hours, according to their weight and the colour they have received, in a temperature of 38° Cent. (100° Fahr.). The skins are next softened by being placed in contact with damp sawdust for one night, and then drawn out by hand on a *pâlisson*, or "staking knife," like that already described, which operation takes out all creases, while at the same time lightening the shade.

Glove-making.

For gloves other than long "mousquetaires," each skin is sheared by hand into a certain number of blanks, about 6 inches long by 4 inches wide, slightly more or less according to size, as marked out by an expert glover. The blanks are drawn out longitudinally to about double their original length, and until they cover the pattern of the size for which they are intended. It will be remembered that, while kid gloves have a seam along the outer side of the little finger, there is none on that of the forefinger. Accordingly, the blanks forming the back and front all in one piece are piled up, 12 deep, alternately with the coloured sides together, just as was the case with the dyed skins.

Formerly each glove blank was sheared out to the required shape separately by hand; but now, for each size of glove, there is a sharp cutting die, made of carefully-tempered steel, about two inches high, and having inside it a metal plate moving therein with easy friction, and kept normally up to the top of the die by springs. Underneath a fly-press with three-threaded screw there is a slide, which is drawn out; and on to this are placed, first the die, then the packet of glove blanks, then a piece of cardboard, and finally a hard-wood block. The slide is then pushed back to its place underneath the press-head, which is now brought down upon the packet, compressing the springs above-named, and cutting the blanks to shape. The pressure is then taken off and the slide again drawn out, the cut blanks, pushed upwards to the top of the die by the springs, being simply removed. This operation cuts the forms of the fingers and the back and front of one glove, as well as the hole for the thumb; and at the same operation are stamped out (in the hole for the thumb) the thumb gusset and the strengthening piece for the inside of the opening at the wrist, and also (from the material left at the end of the little finger) one of the finger gussets, all these pieces being left just adhering, to be severed only at the last moment, in order to prevent their being lost or misapplied.

In addition to the above, two different stampings are required; and they are effected in the same manner, out of pieces trimmed off from the blanks, one for the thumb-pieces, and the other for the *fourchettes à carabin*, or finger sides, the two adjacent being in one piece, and the remaining gussets, also twelve deep. From the waste pieces trimmed off the glove blanks are sheared by hand the long and narrow strips that are used for binding or strengthening the edges of the wrist, and also the opening of the glove where the hand is inserted; and the waste pieces from these, together with those from the stampings, are sold for making glue.

The marking and pricking for the various braidings, more or less elaborate, that generally adorn the backs of gloves (in some cases superseded by pinching the skin so as to form a rib, and stitching it), are now formed by hand punching, as also the button-holes, or the holes to receive the patent fastenings, as the case may be, and the pinking sometimes given to the wrist edges of ladies' gloves.

All the multifarious parts that enter into the composition of the glove have now to be "assembled" (as the French would call it) or put together like the parts of a child's "puzzle;" and this is generally effected by placing together the edges of the pieces to be united, and passing them between two small rollers on vertical axes, one of the rollers being rotated by gear from the sewing-machine, the work being guided by hand. As the glove is drawn forward, the sewing-machine needle, working horizontally and at right angles to the roller axes, produces the seam, leaving visible the white edges of the skin, which in black gloves are rubbed over with dye material.

The principal kid glove manufactory in Luxemburg (which country exports about 50,000 pairs yearly), is that which was started twenty years ago in the suburb of Grund, on the banks of the Alzette, by M. Albert Reinhard, who, beginning as a workman, and still by preference continuing to do his share in the work (that requires great experience) of selecting skins for the various classes of glove, now employs 1,400 hands, and sends out daily about 2,000 pairs of gloves, of which two-thirds find their way to England, and the remainder to the United States of America.

REPORT OF SCREW GAUGE COMMITTEE OF THE BRITISH ASSOCIATION, 1899.*

In the year 1882, a committee of this section was appointed to determine a gauge for the various small screws used in telegraphic and electrical apparatus, in clockwork, and for other analogous purposes. This commitee reported to the section in the succeeding years, 1883, 1884, and proposed that a certain system of screw threads, since known as the British Association screw-threads, should be recommended for adoption by users of small screws in this country. The system is identical, except in one small point, with that used in Switzerland and associated with the

* Report of a committee consisting of Sir W. H. Preece (Chairman), Lord Kelvin, Sir F. J. Bramwell, Sir H. Trueman Wood, Major-General Webber, Colonel Watkin, Messrs. Conrad W. Cooke, R. E. Crompton, A. Stroh, A. Le Neve Foster, C. J. Hewitt, G. K. B. Elphinstone, T. Buckney, E. Rigg, C. V. Boys, and W. A. Price (Secretary), appointed to consider means by which practical effect can be given to the introduction of the screw gauge, proposed by the Association in 1884. See *Journal*, vol. 32, p. 115, vol. 33, p. 1016.

name of Professor M. Thury. The series consists of 26 threads, numbered 0–25, having diameters from 6 mm. down to ·25 mm., and is so closely graduated that only in exceptional cases can any size be required intermediate between two of the set. The form of the thread has proved to be well adapted for practical purposes, and screws made on this system have come into extensive use among English manufacturers of small mechanical apparatus. It has been adopted by several Government Departments, who have imposed its use upon their contractors.

In the year 1895 representations were made to the section, and some correspondents of the technical papers urged, that the value of this system was prejudiced by the fact that purchasers of British Association screws and screwing-tools could not rely on obtaining from manufacturers goods which were interchangeable with one another. This raised at once a question which had not been closely considered by the 1882 committee—viz., the mode of determining whether any given screw of a particular number is or is not a fair representation of the form laid down by the British Association specification. The present committee were appointed at the Ipswich meeting to deal with this point, and with some additional members have sat at intervals up to the present time.

In 1896 an interim report was presented to the section at the Liverpool meeting, in which the problem of the mode of gauging small screws was discussed at length. The principal conclusion reached at that time was that as no means exists of examining a nut or female screw, the efforts of the committee should be directed to obtaining accurate plug or male screws for use as gauges, and combs or chasers.

During the three years that have elapsed since this report was made, the committee have been in communication with different firms, and principally with the Pratt and Whitney Company, of Hartford, U.S.A., a firm enjoying the very highest reputation for work of the kind the committee desired to secure. Finding that this firm were prepared to undertake the production of gauges and tools for the British Association screw-threads on the same lines as they have adopted with the American and Whitworth threads, the committee have been satisfied to leave the matter in the hands of the company till they should ascertain whether they could produce the deeired result, and have given them all the information, specification, &c., that were possible. Within the last two months, the Pratt and Whitney Company have submitted to the committee specimens in hard steel of male and female gauge pieces of threads Nos. 3, 7, and 13. The three male screws of these sets have been photographed by Colonel Watkin on a large scale, and have been measured by Mr. H. J. Chaney, Superintendent of the Standards Department of the Board of Trade.

The committee believe these gauges to be sufficiently accurate for practical requirements. The materials of which they are made—hardened steel—should enable them to stand much use without injury. Their finish and general workmanship are exceedingly good.

The committee, through their secretary, have expressed to the Pratt and Whitney Company their satisfaction with these gauges, and have been informed, in reply, that a higher degree of accuracy may be expected in the future. They are still in correspondence respecting the specifications of limits of error and other details concerning their production on the commercial scale. The manufacture and sale of these gauges by the Pratt and Whitney Company appear to realise the object set before themselves by the committee—viz., to assist the extension of the use of the British Association system of screw-threads by making generally available accurate means for their verification.

While recognising the excellence of the form of the British Association screw-thread for mechanical purposes, the committee feel strongly that the difficulty of producing the form to the degree of accuracy desirable for the best class of work, and especially for gauge pieces, is a serious drawback to its value. Colonel Watkin's photographs show very clearly that the best appliances in the most experienced hands that the committee could find have failed to produce even single specimens of first-rate accuracy. The letters addressed to the secretary of the committee by Mr. George M. Bond, manager of the standards and gauge department of the Pratt and Whitney Company, as well as the high reputation of his firm, leave no room for doubt that very great care has been taken to secure accuracy in these specimens. A considerable number of gauges made by English firms of good standing have been examined by the committee, and have in every case shown errors of the same character as, though usually to a much greater degree than, the specimens submitted by the American firm.

From several sources, and especially in Mr. Bond's letters, it has been urged on the committee that although the difficulties of constructing these gauges of a very high degree of accuracy are practically insuperable, screw-threads of a flat-ended form can be produced with great exactness. A photograph taken by Colonel Watkin of a fine screw taken from an instrument made by Messrs. Brown and Sharpe shows that this is certainly the case.

The American, or flat-ended, form of thread appears to be rapidly establishing itself in France and Germany, judging from the reports we have received of the French and Zurich Conferences, and we understand that it is entirely employed by the French Admiralty, and by several of the French railway companies. These reports refer, it is true, to screws of larger sizes than are included in the range of the British Association and Professor Thury's systems. The conclusions of the recent Conference at Zurich, which adopted the flat-ended thread, were expressly limited to screws of more than 6 mm. diameter, the extreme upper limit of our system. But so far as the easy production of accurate form is concerned, argu-

ments which apply to large screws apply with greater force to small screws; while a form which is suitable for all screws above 6 mm. cannot be wholly unsuitable for screws below that limit. The committee, moreover, were informed by one of their number that he has used screws of the American form in sizes corresponding with some of the smaller numbers of the British Association series, and has found them perfectly satisfactory.

Current conceptions of the possible and desirable limits of accuracy in mechanical construction are rapidly advancing, and while we recognise the value of the work of the committee of 1882, in establishing a generally accepted thread, we are dissatisfied with a standard form for a piece so important as a screw which is open to the serious objection referred to above.

We recommend that this committee shall be re-appointed for the purpose of considering whether the British Association form of thread for small screws should be modified.

POST OFFICE.

The forty-fifth annual report of the Postmaster-General for the year ended March 31st, 1899, has lately been published, from which it appears that the estimated number of postal packets delivered in the United Kingdom during the year was 3,496,513,000, made up of—Letters, 2,186,800,000; post-cards, 382,200,000; book packets and circulars, 701,500,000; newspapers, 154,100,000; and parcels (actual number), 71,913,000.

The number of letters registered in the United Kingdom was 15,240,669, an increase of 7·2 per cent. over the number in the previous year.

London received no less than 28 per cent. of the total number of letters, but the increase during the year was greater in the provinces than in London, London showing an increase of 4·5 per cent. on the previous year, while the increase in England and Wales (excluding London) was 10·8, in Scotland 7·4, and in Ireland 10·3 per cent.

Post-cards have increased in number by 6 per cent. on the year. The rapid growth of correspondence by post-card is indicated by the fact that the total given above is more than double the total recorded twelve years ago.

The number of newspapers shows an advance of some three millions on the total given in the last report. The returns from the different parts of the kingdom vary somewhat, it being estimated that the number of newspapers delivered in the rural districts of all parts of the United Kingdom increased. In Ireland the increase was nearly 10 per cent.

Two causes have combined to cause a decrease in the number of book packets delivered. The book-post has been limited during the whole of the year to packets not exceeding 2 ozs. in weight, and there have been fewer "heavy postings" of prospectuses and circulars at the chief office.

The total number of parcels delivered during the year, viz., 71,913,000, was 6 per cent. higher than the number for the previous year, and more than double the number delivered 12 years ago. The average postage on inland parcels fell just short of 5d. Of the total number 61,777,000 were rail-borne, and 10,136,000 road-borne. The railway companies received £705,732 as their share (55 per cent.) of the postage on the rail-borne parcels; the postage retained by the Post-office amounted to £792,367. Inland parcels, to the number of 761,801, were registered during the year.

The number of express services reached a total of 641,227, an increase of 16 per cent. on the total of the year 1897-98. 684,500 articles were delivered by express messengers in London, including 282,420 ordinary letters delivered by special messenger in advance of the postman.

Another change made in the service during the year has been the introduction of a delivery of express letters in London on Sunday. The new service was introduced on the 12th February last, and while it is found to add very slightly to Sunday work, it is undoubtedly a boon in cases of special need.

The international express service was extended during the year to France, Algeria, and Corsica for parcels, and to British Guiana and to St. Lucia for both letters and parcels.

The number of undelivered packets dealt with in the year was very considerable, viz., letters, 8,553,936; post-cards, 1,387,084; book packets, 11,301,606; newspapers, 553,622; and parcels, 188,837.

The total value of property in letters opened in the returned letter offices was £720,610.

As many as 44,360 letters were posted without address during the year, and 2,421 of these contained property to the value of £7,076, one letter having in it an uncrossed cheque for £500 payable to bearer. Other articles posted without address were 9,225 post-cards, 102,820 book packets, and 130,635 newspapers. The number of parcels found in the post without address was 14,066.

IRON AND STEEL INDUSTRIES IN 1899.

Owing to the very exceptional pressure that has been put on ironmakers during the present year, there has been a general idea that the make of iron must have been much larger than usual, and larger than would merely be represented by the additional number of furnaces in blast compared with the first six months of last year. On the other hand, owing to the comparative difficulty in procuring adequate supplies of iron ore and fuel, it has seemed to be probable that the blast furnaces have not been worked so regularly or to the same extent of their capacity as the demands of buyers would have rendered otherwise expedient.

ndeed, some writers on the subject have gone the ngth of conjecturing that the increase of demand is not, for that and other reasons, been met by a orresponding increase of supply. All doubts on the ubject have now been set at rest by the official atistics collected and published by the British ron Trade Association, which show that the total ake of pig iron in Great Britain for the first six onths of 1899 has amounted to 4,782,868 tons, gainst 4,432,893 tons for the corresponding six onths of 1898. This is an increase at the rate of bout 700,000 tons a year, and if it is maintained, as is pretty certain to be during the second half of the ear, will make the output of 1899 over 9,500,000 ons, which is, of course, a record. Indeed, in no revious year has the pig iron output come up to .000,000 tons, so that the year 1899 will apparently ot only signalise the largest production of pig-iron on ecord, but it will also be notable for one of the largest lvances in the history of the trade.

It will be remembered that the production of outh Wales was last year seriously affected by the rike of miners, which made it practically impossible o procure local supplies of fuel. It is not, therefore, urprising to find that the largest amount of increase as taken place in that district, where the total make or the first six months of 1899 has been 467,960 tons, gainst only 245,085 tons in the corresponding six onths of 1898. In several of the other districts, owever, there has been a reduced production of on, and as that has taken place in the face of n almost unprecedented demand, and of an advance of nearly 50 per cent. in prices it may be ssumed that in the districts where this has happened influences were at work which prevented he ironmakers from producing so much as they ould otherwise have done. These districts include leveland, Lancashire, and Northamptonshire, but in one of them, except Lancashire, has the reduction een very material. The imports of iron ore from pain and other countries have been the largest on ecord, and exceed by about 600,000 tons those of f any corresponding six months in the history of the ade. This is regarded as a good augury for the uture, and the fact should go far to relieve the pprehensions that were generally entertained, and e in some quarters still felt, lest a scarcity of ores ay compel a restriction of pig-iron output on a conderable scale. And this satisfaction is emphasised y the knowledge that new sources of supply are very now and again coming into view, one of the test being a large deposit in Algeria, while several omparatively new fields are being tapped in Spain. Ioreover, the home deposits of ore are being proved be more abundant than was anticipated, several ew sources of supply having been opened out in West Cumberland, Northamptonshire, and elsewhere. inally, there is the iron ore field, which has recently een proved in Kent, and whence it is probable upplies will ultimately be drawn. About twentyve more furnaces have been in blast during 1899 than were worked in the previous year, and twenty-five more are being rebuilt, or new furnaces in course of construction, so that there is every prospect of a further increase of output if raw materials are sufficiently cheap and abundant.

Stocks of pig-iron all over the country are, however, exceptionally low. At the end of June there were 688,190 tons in public stores, and about 250,000 tons additional in the hands of makers. This is less than six weeks' make, so that the iron in reserve is not over abundant. There is not the same pressure of demand that there was a few months ago. Makers appear to have plenty of orders on hand, and the Continental demand is still very strong. Nevertheless, stocks in some cases are increasing, and especially on the West Coast. If, therefore, there was at any time a danger of a pig-iron famine, which the best informed authorities do not admit, that possibility is daily becoming more remote. Much will, however, depend on the iron trade situation in the United States. Should the Americans make large demands upon British blast furnaces, which is regarded as possible, prices may still run up to a figure that would lead to difficulty.

The statistics of the steel industry show that in the first six months of the present year the production of steel was:—

	Acid (tons).	Basic (tons).	Total (tons).
Open hearth	1,443,398	137,291	1,581,319
Bessemer ...	748,919	257,003	1,005,922
Total ...	2,192,317	394,924	2,587,241

Here, again, there is a record output, taking the two descriptions of steel together. The make of open-hearth steel has exceeded by 276,000 tons the make of the corresponding six months of 1898, which was the next largest make in the history of the British steel trade, or, indeed, of the open-hearth steel trade of any country. The make of basic steel is also a record. The largest advance has taken place in Scotland, where the output of open-hearth steel in the first six months of 1899 was 517107 tons, against 392,350 tons in the first six months of 1898. In all districts alike there has been an increased output in 1899. The make of this description is now at the rate of over 3,000,000 tons per annum, and there is every likelihood that the total make of both descriptions for the year 1899 will considerably exceed 5,000,000 tons. This large increase has been mainly due to the enormous requirements of the shipbuilding trade, the ascertained make of steel ship plates for the first six months of the year 1899 having been over 700,000 tons, or at the rate of 1,400,000 tons a year. In many cases provision is being made for adding to the many sources of production. This, however, is to a considerable extent being done, not so much by an absolute increase of furnaces as by increasing the dimensions of the newer plant, and thereby securing a much larger output for a given number of furnaces. In other words, 40 and 50 ton furnaces are now to a large extent taking the places of furnaces of much smaller capacity. The total

number of furnaces now available for smelting steel by the open-hearth process is about 400, and a number of new furnaces are being erected.

The statistics of both the open hearth and the Bessemer steel industry for 1899 show quite clearly that there has been no real scarcity of pig-iron. Otherwise the steel output could not have advanced as it has done. At the same time, the increased cost of pig-iron and of fuel, have, to a large extent, upset the calculations of steel manufacturers, many of whom found themselves with low-priced contracts on hand, which they were, in some cases where they had not fully covered their pig supplies, obliged to work off at a loss. Most of these old contracts, however, have now been got rid of, and, at present prices, it is probable that steel makers are doing as well as they have ever done. The outlook of the trade is regarded as exceedingly favourable, and there are not a few who believe that it will become even more so, but this, again, will largely depend on what our American friends may do in the way of placing contracts on this side of the Atlantic.—*The Economist.*

PROCESS OF DRY CLEANING.

The following article is from the *Dyers' Bulletin*, quoted in the *Journal of the Society of Dyers and Colourists*:—

There are a number of methods of dry cleaning, according to whether the industry is to be carried on in a small way or on a large scale. For the latter, a well-equipped workroom is ordinarily furnished with five cylindrical vessels, higher than they are wide, and of a size to just allow of the handling in them of the goods to be cleaned. They may be made of zinc, but copper kettles are to be preferred, or the large stoneware pots used in chemical works; each of them must be provided with a well-fitting lid. The articles to be cleaned are first sorted. These articles comprise:—(1) White silk tissues and ribbons, and such in which besides other colours white predominates; (2) woollen and half-woollen light coloured goods; (3) velvets and all other coloured silk goods; (4) woollen and half-woollen goods of medium shades; (5) dark-coloured articles.

Less available for dry cleaning are half-silks, all cotton and linen goods; and white cotton or linen articles, and such as cannot properly be placed into a washing machine, ladies' hats, satin shoes, &c., must be turned over to wet washing or cleaning by hand. Of the goods suitable for dry cleaning the light coloured are separated from the darker ones, and thrown in separate heaps. Then each piece, the light coloured first, is spread upon a table whose top is covered with zinc, and the coarsest stains or dirt washed out by means of the tampon saturated with benzin, which is placed handy in a cup. The dark pieces are treated last, because the benzin in the cup becomes gradually dark by the tampon being repeatedly dipped into it. The remaining benzin poured into a large receiver, with lid, and afterwar added to the dirty benzin from the washing machir &c., for distillation. After filling each of the fi vessels to three-fourths of its capacity, the goo classified as indicated, are washed in the same ord one after the other, in the first vessel and then throv into the second, which is then covered with its li Then a fresh lot is washed by hand in vessel No. the first treated lot transferred from vessel No. 2 No. 3, and the second lot from No. 1 into No. while a third lot is being washed in the first vesse the first treated pieces are from No. 3 thrown in No. 4, the following set from No. 2 into No. 3, a the third from No. 1 into No. 2.

The shifting of goods from one vessel to the oth takes place because the benzin in the first vesse where the goods are washed out, becomes dark with every succeeding lot, while the first lot, that the white goods, are only brought into contact wi clean benzin. The first lot is now again washed vessel No. 5, then again spread upon a table ar examined, and if still dirty spots are found, th material is by means of a clean tampon, or brus treated with benzin from the last vessel, and la down in it for a while. For the preparatory trea ment, as well as this supplementary cleaning, stron brushes may be used instead of tampons, an naturally, softer brushes for thin goods; gauz grenadine, &c., are not brushed at all. Silks mu be brushed pretty hard throughout; as long as th brushes are well saturated with benzin, no damage t the goods or destruction of the gloss need be appre hended; other thin materials are brushed in th direction of the warp, hooks and eyes, &c., must b removed.

When done, the goods are for draining thrown int a zinc or copper cylindrical vessel with lid and per forated false bottom, and an outlet at its lower part and finally the benzin still remaining in the goods i pressed out by a clothes wringer, or whizzed out b hydro-extractors, for hand-power in smaller concern or for steam, &c., power in large establishments There are hand-power extractors which perfectly mee the requirements of medium-sized cleaning works where only a few hands are employed. The cleane goods are finally dried in a well-ventilated dryin room or drying box, with outlets for the benzi vapours, at a temperature of 70 to 75° C., provide no stains have remained upon the goods, after th washing in benzin, which must be individually re moved as indicated heretofore.

In large establishments, where much and rapid work is to be done, the foregoing described washing machines, driven by steam or other high power, are employed instead of the above-mentioned five washing vessels. The machine, or rather the outer drum, is filled with the cleaning liquid to about one-fourth of its capacity, so that the liquid rises to about 10 or 12 c.m. (3 to 4 inches) within the inner or slat drum. Then the goods to be cleared are entered, as they

ave been separated in several lots, each lot separately nall articles, such as cravats, ribbon, and very thin d fine tissues which are liable to fall through the ats of the inner drum, tied in a muslin bag), the oors of both drums are closed and fastened, and the achine put into motion, and run for eight minutes one hour with varying velocities, according to the ature and condition of the goods, as before stated. hen the goods are rinsed in the rinsing tub in clean enzin, hydro-extracted and dried in the drying room 70° to 75° C., and can in one to two hours be moved from the drying room perfectly free from the enetrating odour of the benzin. Smaller concerns, hich have no properly constructed drying room, but ily drying boxes, give the dried goods an airing, to move this odour, on the loft, which, however, quires a considerably longer time.

But with the benzin treatment, drying and deodoring, the cleaning proper is not yet ended. If the emoval of stains has not taken place before the eneral scouring, the goods must be carefully examed for stains which the chemical treatment has not emoved. If such is the case, the goods are placed pon a marble slab, or even a table which is covered ith good oil-cloth or only with clean muslin or milar material, and the stains wiped out with a rush and water and soap. The most tenacious stains re those from oil-paints and resins. These are ouched up by means of a tampon with oil of turpenne, a piece of filter paper or thick blotting paper laced under, and another piece put upon them, nd a hot smoothing iron passed over it, finally the rticle is washed in warm soap-water, and after ufficient draining, ironed dry. Very woolly goods, aving a strong nap or pile, which have become flat y ironing, are passed over a steam table or steam oner, whose perforated top-plate is covered with a trong felt cloth, flannel blanket, or similar material. On turning the steam on, the goods being passed ver the top of the apparatus left side down, it penerates them from below and immediately raises the ile to its original position, making the goods look ke new, provided the cleaning itself has been properly nd effectually carried out.

GERMAN LACE AND EMBROIDERY TRADE.

The German lace and embroidery trade was less ast year than in the previous year, but Great Britain till takes the largest part of the exports. It amounted o 11,043 cwt., or 44·8 per cent. of the entire export. New technical schools for this industry have been opened in Saxony, it being considered a necessity to educate capable machine embroiderers, if the trade is o maintain its present high standard.

The Saxon weavers were very dissatisfied with the business of the past year. Good trade was, however, done in chenille curtains and table-covers for Great Britain. The Saxon manufacturers of lace and woven stuffs complain that the Nottingham firms will not do direct business with them, and refuse to sell even an inch of net except through the medium of the agents. It seems necessary to point out to these firms that such a procedure is liable to injure their trade with Germany.

The import of net, which is principally used in the lace embroidery industry, was only 9,336 cwts., or a diminution of 7·1 per cent. The reason for this was the diminished sales of such articles, and the manufacture of German net. Several factories have been started in Saxony for this purpose, but it remains to be seen whether these new undertakings will permanently injure the British trade. In order still more to foster the home industry, it has been suggested to raise the duty on foreign net. By far the greater part of the imports last year, 8,942 cwts., or 95·7 per cent., came from Great Britain.

The German "posament" or lace industry, which employs many thousand hands in the Erz-Gebirge, showed last year a great improvement on the previous year. The export of German lace, buttons, &c., showed a considerable increase. Of the entire export of 111,191 cwts., with a value of £2,256,618, 38,126 cwts., or 34 per cent., went to England. It is thought in the trade that a still further increase in the exports will take place.

The "English curtain" industry, which, as is well known, has its principal seat in Saxony, and especially in Falkenstein, has found new centres in other Saxon towns, in Zwickau, Dresden, and Zittau. An English factory has been started at Uhingen, near Stuttgart, in Wurtemberg. In Falkenstein, about 140 curtain looms are working, all of which have been sent from Nottingham. Efforts have been made to make the machines in Germany, but Mr. Consul Schwabach is assured by competent persons that these cannot compare with the British machines. It is true that quite lately the firm of E. H. Lange has succeeded in making looms which are said to be easy to work, and which produce well-made goods. If, however, the British makers keep up to their present high standard, and endeavour still more to perfect their machines, they need fear no permanent competition in this direction.

In regard to the "improvement" trade in Madeira embroidery, the following fact is of interest. In October, 1897, the Minister for Trade and Commerce asked the opinion of the Berlin Trade Union on the question, if it were advisable to permit the free transit of goods to and from Madeira for the purpose of "improvement." The Minister was advised to allow this trade to continue duty free, as it could not be said to injure German trade, but was, on the contrary, of decided benefit to the German industry. The Finance Minister conceded the free traffic in this article until further notice. Efforts were again made to introduce a duty on this article, and competent persons were again consulted, but with the same result, and the "improvement" traffic still continues duty free.—*Textile Mercury*.

Notes on Books.

MUSICAL PITCH: Letters, Articles, and Comments in the Press on the Proposal to Adopt the Low Pitch throughout the Pianoforte Trade. London (Waterlow and Sons): 1899. Folio.

This pamphlet contains a reprint of the chief articles and letters which have appeared in the English Press on the controversy respecting the general adoption of the New Philharmonic Pitch, from the beginning of the controversy on the 4th of July until August 31st, the first communication being Messrs. John Broadwood and Sons' letter to *The Times*, in favour of the New Philharmonic Pitch (A = 439 double vibrations at 68° Fahrenheit), derived from the Diapason Normal A = 435 at 59° Fahrenheit. A list is given of the pianoforte manufacturers who have signed the agreement in favour of the general adoption of the Low Pitch, which is as follows:—"The vexed question of a suitable pitch for pianofortes should be settled, and believing the time has arrived when it can be done, we, the undersigned, after due deliberation, have decided to adopt the Paris Diapason Normal, but with the allowance for a higher temperature in orchestral performances, accepted since 1896 by the Philharmonic Society, viz., A = 439 (C = 522) at 68° Fahrenheit. From the 1st of September, 1899, we intend to adopt this pitch as a standard for pianofortes, both for retail and wholesale purposes, and with regard to the late Philharmonic Pitch, A = 454 (C = 540), when required as an exception, and not, as has been for many years in this country, the rule." It will be remembered that the Society of Arts' pitch (C = 528 vibrations), which was adopted in 1860, was given up by the Council of the Society in 1886, in favour of the French pitch (A = 435, or C = 517·3). The reasons for this action are given in a report of the Society's Committee, and printed in the *Journal* Feb. 12, 1886 (vol. xxxiv. p. 265).

PRACTICAL ELECTRICITY AND MAGNETISM. By John Henderson, B.Sc. Longmans, Green and Co. 1898.

This is the second of the series of laboratory manuals edited by Mr. Henderson and Mr. Joyce, the first being a treatise on elementary physics, by the same author. It is intended for fairly advanced students, and is meant to be used as a companion in practical laboratory work. The work consists of six chapters, the first five of which deal respectively with the Measurements of Resistance, Current, Electromotive Force, Quantity, and Capacity, while the last is devoted to Magnetism. The construction and use of the instruments used, galvanometers, resistances, standard cells, &c., are carefully described, and full practical directions are given to the student. At the end of each chapter are references to important papers dealing with the subject-matter of the chapter.

General Notes.

METROPOLITAN ASYLUMS BOARD.—According to the report of the Board for 1898, the total expenditure was £719,128, showing an increase of £53,735 over that of the preceding year. The expenditure is roughly summarised as follows:—(I.) For imbeciles, £140,135; (II.) for infectious sick, £319,069; (III.) for ambulance services, including medical department, £30,739; (IV.) for boys under training, £18,857; (V.) for children, £4,530; (VI.) for general expenses, including repayment of loans, £205,798.

SANITARY INSTITUTE.—The 28th course of lectures and demonstrations for sanitary officers will be delivered on Mondays, Wednesdays, and Fridays, from September 15th to November 29th, 1899. The course will comprise the following lectures:—Part I.—Six lectures on elementary physics and chemistry in relation to water, soil, air, and ventilation; two lectures on elementary statistics, meteorology, and local physical conditions. Part II.—Eighteen lectures on public health statutes; the practical duties of a sanitary inspector, *e.g.*, drawing up notices as to sanitary defects, drain-testing, disinfection, methods of inspection, note-taking, and reporting; municipal hygiene or hygiene of communities; building construction in its sanitary relations; measurement and drawing plans to scale. (Inspections and demonstrations will be arranged in connection with the lectures.) Part III.—Seven lectures on meat and food inspection, including taking of samples of water, food, and drugs for analysis. (Practical demonstrations of meat inspection will be given.)

SCHOOL BOARD FOR LONDON.—The number of pupils admitted to the Evening Continuation Schools, conducted by the School Board for London, last session, rose from 57,586 to about 109,000, showing an increase of about 51,414 compared with the numbers in the preceding session. The 18th Session commenced on Monday, 11th September. As many as 348 schools for general instruction were opened, and, in addition, there were twelve special schools for commercial work, and eight special science and art schools. Lectures in literature will be given in 21 schools, gymnastics will be taught at 58 centres, and ambulance and home nursing will be taught by doctors in upwards of 100 schools. There will also be facilities for women and girls to learn practical cookery, dress-cutting and making, and laundry-work, and for men and boys to receive instruction in woodwork. Some form of physical exercises will be taught in all schools. Students are prepared for the examinations of the Science and Art Department, Civil Service, Society of Arts, &c., and prizes and certificates are awarded. Applications for prospectus should be made to the Clerk of the Sub-Committee on Evening Continuation Schools, School Board for London, Victoria-embankment, W.C.

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FRIDAY, SEPTEMBER 22, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1900.

The dates fixed for the Examinations in 1900 are Monday, March 26th; Tuesday, 27th; Wednesday, 28th; and Thursday, 29th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix, containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, W.C.

THE SOCIETY OF ARTS.
(1754-1899.)

The Society of Arts is one of the three oldest of the learned and scientific societies in the country, for when it was founded in 1754 only the Royal Society and the Society of Antiquaries were in existence. As it had a large field to itself, it was comprehensive in the scope of its work. For a long time it alone filled the place which is now occupied by the many societies which have since been founded for the promotion of special branches of science, industry, and art. It was—as indeed it still is—at once scientific, technical, industrial, commercial, and artistic. Before the foundation of the Royal Academy it held exhibitions of pictures, and assisted in the education of art students by prizes and examinations. Until the Royal Agricultural Society was established, it was the principal institution in the country for the promotion of agriculture and the application to agriculture of scientific principles. It anticipated the Institution of Civil Engineers, and the other engineering institutions, in the encouragement of civil and mechanical engineering. It encouraged chemical research, and the application of chemistry to industry, before the Chemical Society and the other chemical institutions which in later years have dealt with various branches of that great science. And it promoted arts and industries in the Colonies more than a century before the Royal Colonial Institute or the Imperial Institute.

During the first half century of its existence the objects of the Society were principally attained by the award of premiums for useful discoveries and inventions. In this way it distributed £28,434 between the years 1754 and 1783. There was probably at the time no better way of discovering meritorious inventions, and bringing them to public notice, though it was liable to the obvious imperfection that the prizes could be awarded only in accordance with the best knowledge of the time, whereas the objects to be rewarded were, or ought to have been, in advance of such knowledge.

In the department of Fine Arts, it had a share in assisting the education, and encouraging the youthful efforts of many of the most eminent artists from the time of Reynolds to our own days. On its prize lists are found the names of Richard Cosway, Joseph Nollekens, George Romney, Sir Thomas Lawrence, P.R.A., Sir William Ross, William Mulready, Thomas Bewick, Aloys Senefelder (the inventor of lithography), John Flaxman, W. Wyon (the medallist), Sir Edwin Landseer, Sir Charles Eastlake, P.R.A., W. P. Frith, J. C. Hook, Sir J. E. Millais, P.R.A. One of the first, if not the first public exhibition of pictures in London was that held in 1760 at the Society's rooms in the Strand, near Beaufort-buildings, an exhibition which really led to the foundation of the Royal Academy in 1768.

The improvement of Agriculture was one of the very earliest objects of the Society, and the first volumes of its Transactions are devoted in large measure to this subject. Indeed, so important a branch was it of the Society's operations that the publication which practically served as the Society's Transactions for the first few years of its existence was known as "Dossie's Memoirs of Agriculture." It would take too long to record even a selection of the improvements it effected, or tried to effect. Some of the more important may be merely mentioned. The want of timber for shipbuilding and other purposes was one of the great needs of the country at the time of the Society's foundation. The country was to a large extent deforested, and some organisation was required to prevent the spread of the evil. An earnest effort was made by the

Society to attract public attention to the need for renewing the stock of timber. Between the years 1775 and 1781, twenty-two gold medals and a few smaller prizes were presented to landed proprietors in various parts of the country. About three-quarters of a million trees were planted under these awards. The attempt was entirely successful, thousands of acres were planted, and, as a practical result, the supply of timber was renewed. Many of the woods throughout the country owe their present existence to the initiative of the Society of Arts.

The encouragement of the Arts and Industries of the Colonies was another of the first objects to which the Society devoted itself. The Colonies of the country, it is to be remembered, were then all situated in North America (now the United States) and the West Indies. Prizes were given for new colonial industries, for the introduction of machinery into the Colonies, for the importation into this country of colonial products. Contemporary records show how greatly the Society's efforts were appreciated in the West Indies and in the American colonies. Many valuable plants were introduced abroad, and many valuable products brought home through the agency of the Society.

A special division of the Society was devoted to mechanics and manufactures, and another to minerals and chemistry. By means of the two committees which dealt with these divisions, large sums were distributed in prizes and donations to meritorious inventors. The range of work of these two committees was so wide that it is difficult to give even a summarised account of what they did in the first sixty or seventy years of the Society's life; but it may safely be said that there was hardly a single branch of industry at the time which was not helped forward by their efforts. The manufacture of iron, textile manufactures, chemical manufactures, and, in later times, all the various applications of science to manufacturing purposes received a share of the Society's attention. Perhaps some of the prizes were ill-bestowed, and many deserving inventions were refused awards. Looking back through the old records of the Society it is not difficult to discover occasional instances in which rewards were refused to inventions in which present knowledge can perceive the promise of future discovery. But on the whole the premiums were judiciously bestowed, and were of much value in stimulating and rewarding invention. But for the unwise prejudice which prevented the recognition of any patented object, the premiums would have been more useful still.

As time went on it was found that the award of prizes for meritorious inventions was not the most advantageous way of attracting public attention to them. The opinion of a committee on a new and untried invention is very liable to error. The more novel the invention, the more varied from previous ideas, the less likely is it to commend itself. This was even truer at the beginning of the century than now, when the great and startling developments of science have rendered public opinion less intolerant of novelty.

It was found that the best test of merit was practice, and the best service that could be rendered to an inventor was to give him the opportunity of publicity. In the industrial, as in the material, world, the rule of the survival of the fittest holds good. Hence the practice was instituted of holding meetings, at which new scientific discoveries and their applications were described and discussed. This idea seems to have been mainly due to Mr. William Aikin, the distinguished chemist, who was secretary to the Society in the early part of the century; and he introduced the practice of delivering lectures on various branches of industry and improvements connected with them. In 1842 the practice was reduced to a system, and from that time to the present day one of the most useful portions of the Society's work has been the holding of such meetings for the reading of papers and the delivery of lectures.

The recorded reports of these meetings for many years past form a continuous chronicle of the progress of the applications of science and of art to practical purposes, and there have been few of the prominent technical scientific discoveries of recent years whose introduction to public use has not been assisted by the Society of Arts. The long series of "Cantor Lectures" delivered before the Society form almost a full industrial cyclopædia. In their delivery, their special educational value was very great, and their published reports form a useful contribution to the industrial history of the country.

While referring to the Society's meetings special reference should be made to those of the Indian Section, the value of which in promoting a knowledge in this country of subjects relating to the Empire of India has long been and is still constantly recognised by the Government of India and by the India Office. If the work of the Foreign and Colonial (originally the

African) Section has been less important, that is only because its special field of labour has for some years been occupied by the Colonial Institute, and more recently still by the Imperial Institute, a body whose very existence is a high testimony to the work of the Society of Arts, founded as it was by H.R.H. the President of the Society on lines similar to the older body, and to carry out, under more influential auspices and on a larger scale, precisely the same work.

As special institutions came to be established to deal with various branches of science and industry, the Society gradually abandoned some of its older fields of work, but it has still remained the one unspecialised Society, always ready to afford an arena for the discussion of any prominent subject coming within its rather wide scope. There are now some fifty scientific societies meeting in London, dealing with different branches of science. It is not too much to say that the greater number of them deal with subjects at one time or other included in the Society of Arts programme. Many of them originated more or less directly from the Society of Arts. Some originated at meetings held at the Society of Arts' rooms, others were promoted by the more active members of the Society at the time. It may, however, be said that, as each relieved the Society of some of its work, it left behind more than sufficient new material to occupy the energies of an institution dealing not with special departments of science, but with the practical application of all departments.

For it may be said that the only way in which the Society has differentiated itself from other institutions of a similar nature is that it devotes itself principally to the application of science and of art to practical purposes. Its value in this direction was recognised by the Prince Consort, who found it a most useful instrument for carrying out his own ideas, and impressed upon it much of the character it now bears.

Apart from its regular work, holding meetings for the advancement of knowledge and the dissemination of useful information, the Society has devoted itself to a vast number of definite public objects, to the promotion of which its organisation has been in various ways applied. Some of them may at least be mentioned. Perhaps the most important service ever rendered by the Society was the establishment of International Exhibitions. The first Exhibition of 1851, as is well known, was originated, and its organisation carried on till it could be handed over to a Royal Commission, by the Society. In the same way the Exhibition of 1862 was started, and to a large extent carried out by the efforts of the Society.

Another great branch of the Society's work is that dealing with education. Through its efforts was originated the system of carrying out local examinations from a common centre, which soon after received such full development through the agency of the Science and Art Department. The Society's examinations, founded in 1856, though its example has been followed by other agencies, amongst whom must be specially mentioned the Local Examinations of the Universities, still continue to be the only examinations of an important character dealing with commercial education.

It was the Society of Arts that first drew public attention to the need for technical education, and, by the holding of conferences and discussions on the subject, aroused the public feeling which led to the appointment of the Royal Commission of 1881, with all the vast developments of that branch of education which have followed the report of that Commission. Among the many institutions whose establishment was fostered by the Society may certainly be mentioned the City and Guilds Institute for the promotion of technical education, which at its origin was greatly assisted by the Society, and has of late years developed into a most important educational agency, the system of technical examinations founded and carried on by the Society on a small scale for some years, in spite of opposition and indifference.

The great improvement in decorative art which has marked the last half of the present century in this country may be said to have had its birth in the Society of Arts. Chiefly owing to the strenuous efforts of the late Sir Henry Cole, the Society originated a campaign against the ugliness and ignorance in artistic matters which was certainly prevalent in England about the end of the first half of the century. Its efforts were for a long time met with ridicule, but public opinion was gradually converted, and the value of beautiful and artistic surroundings in daily life, instead of being a matter to be sneered and laughed at, is now regarded as a matter of course.

It would perhaps be too much to say that the attention which matters of public health now receive was entirely or even in the main due to the efforts of the Society, but it did a most valuable public service in popularising a know-

ledge of the subject, and disseminating accurate information on sanitary matters by means of the conferences it held on sanitary subjects from the years 1876 to 1879.

Many other public objects have been initiated or promoted by the Society. It took an active part in the improvement of the Patent-law, since the first improvements in 1852 down to the last Patent Act of 1883. It was the action of the Society that first secured protection for copyright in works of art. Its Food Committee was one of the earliest agencies to draw attention to the necessity of providing means by which meat and other foreign food products could be successfully imported. One of its committees for a long time urged on the Post Office the necessity for a Parcel Post (suggested in 1858), and worked up public opinion until it was granted. Another for a long time urged the necessity of cheaper telegraphic communication, and suggested to successive Postmasters-General the desirability of shilling telegrams long before they were granted.

The Royal College of Music was founded as the National Training School for Music by the exertions of the Society. As far back as 1839, the Society dealt with the question of uniform musical pitch, and established a pitch of its own which was only recently formally abandoned in favour of the better-known French *diapason normal.*

The introduction of moderate-priced scientific apparatus was initiated by the Society of Arts' Microscope in 1855. Thousands of these instruments were sold for three guineas, at a time when it was believed that no microscope of any practical value could be produced for four or five times that amount.

The idea of marking, by distinctive tablets, houses associated with the names of distinguished men, originated with this Society, and has in London been carried successfully into effect. Such historical houses are fast vanishing, and the attempt to rescue them from forgetfulness has been very popular and, it is hoped, useful.

The whole of the work of the Society of Arts has been carried out without any Government aid, or indeed without any endowment. It is practically dependent entirely upon the annual subscriptions of its members. Its present income is about £10,000 a year, and this is expended annually. It has in past years received a certain amount of money by way of legacies, and it possesses trust funds amounting in all to £14,000. Most of these trusts are chargeable with the award of various prizes. It has about £17,000 of its own, unaffected by trusts of any kind, mainly accumulated during the past twenty-five years out of surplus revenue.

The buildings in the Adelphi, which it has occupied since 1775, are not freehold. The original lease expired in 1867. It was renewed for a period of thirty years, which expired in 1897, and the lease was further renewed for a period of seven years, ending in 1904. The accommodation is now hardly sufficient for the needs of the Society. It is especially deficient as regards the requirements of a library, and the want of convenient library accommodation has for many years past been a serious drawback. There is every reason to believe that with ampler premises the operations of the Society might be extended, a greatly increased number of members attained, and consequently larger funds provided, which might be expended in objects of public usefulness. The Society's meeting-room has been largely used by other societies, to whom it has been readily lent, and for public meetings for objects cognate to the work and purposes of the Society.

*ELECTRICAL MACHINERY ON BOARD SHIP.**

Everybody is familiar with the great advance in comfort on board ship following the substitution of electric lights for candle and oil lights, and it is only natural that ever since the first application of electricity, endeavours should have been made to extend its use on board ship.

The first part of the electrical system to be developed was the generating plant, as it was very soon apparent that belt-driving, otherwise universally resorted to, was not reliable enough. As a first improvement, Mr. J. S. Raworth constructed rope pulleys for an endless rope, which could be stretched while running by means of a movable guide pulley. This rope gear, although it avoided the danger due to the belt slipping off the pulleys, shared with the belt-driving the serious disadvantage of occupying too much space.

About the same time, Brotherhood engines, running at a high speed, were first used coupled direct to dynamos; but their construction at that time was not very well understood, and the ships' engineers greatly preferred double-acting engines of simple construction. To meet their views, and to economise space, Mr. Haworth constructed a friction driving gear, which has been extensively used, and merits, therefore, a short description. The dynamo is bolted to a cradle which can rock the dynamo in the direction of the armature spindle, and this carries a pulley of com-

* Abstract of paper by Alexander Siemens, M.Inst.C.E., read before the British Association meeting at Dover.

pressed paper, which is driven by the fly-wheel of the steam-engine, against which it is pressed by adjustable springs. The cradle supporting the dynamo is placed between the steam-engine and the fly-wheel, so that the whole arrangement is very compact.

After this gear had been in use for some time, Mr. Charles Hall, the electrical engineer of the P. and O. Company, suggested driving the dynamo direct by a Tangye engine at the comparatively low speed of 180 to 200 revolutions per minute.

This type of generating plant has practically been adopted for all modern ships, and it may be observed in passing that direct driving is nowadays recognised, even in places where there is no want of space, as superior to belt driving for all purposes.

In view of the contention that English practice is lagging behind that of other countries, it is as well to remember that at the Chicago Exhibition the two or three direct-driven sets were almost ridiculed by the American engineers, who confidently predicted that the Old Country would soon drop this practice, and adopt the American method of belt driving.

As a plant typical of the American practice of that time, the power plant of the Brooklyn Tramways can be mentioned, where Corliss compound engines drove a fly-wheel, from which a belt, five feet wide, drives two dynamos on the first floor of the building.

It is needless to say that direct driving is now as much in use in the United States as it is here, and, in fact, everywhere. There can, therefore, be little doubt that the type of generating plant adopted on board ship has reached a stage in its development which, no doubt, will be improved, but will not be materially altered.

When electricity was introduced on board Her Majesty's ships some inconvenience was caused by the magnetic field of the dynamos affecting the ships' compasses in cases where iron bulkheads happened to be near the dynamos, and extended to the neighbourhood of the compasses. In order to guard against eventualities of that kind it is now usual to employ iron-clad dynamos on the men-of-war. For the same purpose, the distribution of the electricity is in most cases effected by the double wire system, the flow and return being laid side by side to all points of utilisation. These conductors form the most valuable part of the electric system, through being easily adapted to the scanty accommodation on board, readily repaired, without danger arising from their being damaged, when they are properly fitted up, and easily tested to ascertain that they are in working condition.

Such qualities contributed not a little to the speedy introduction of the electric light, but they are still more appreciated for the distribution of power. The larger the ships are the more it becomes necessary to supplement manual labour by mechanical power, and it is a trite saying that modern ships are nothing but machine shops.

Until lately it was usual to drive all this auxiliary machinery by small steam-engines or by hydraulic power, and this necessitated a network of piping all over the ship, which is difficult to arrange neatly, and which gives endless trouble through leakage. In addition, there are waste products from all the auxiliary steam-engines, and their disposal requires additional pipes and complications. All this inconvenience is avoided by employing electric motors, and for certain purposes, where the load on the motor does not vary much, they have been generally introduced.

That their use has not been more extended is due to the difficulties which arise from variations in the load on the auxiliary machinery. Taking the case of a winch, it frequently happens that the strain on a cable increases sufficiently to stop the movement of the winch altogether, and this would cause the current through the electric motor to rise to a dangerous extent. It is impracticable to protect the motor by a fuse, as the interruption of the circuit through the blowing of the fuses would allow the strain being taken off the winch, and in most nautical operations it is necessary to keep the strain on.

There are two methods in use to overcome this difficulty, one is to employ shunt-wound motors, running continuously, and operating the winches, &c., through friction clutches; and the second is to employ special cut-outs in connection with series-wound motors. By these cut-outs the current through the motors is not interrupted altogether, but if the winch or other machinery is stopped so that the current becomes excessive, the main circuit is interrupted, and a bye-pass only left, in which sufficient resistance is inserted to allow only the maximum safe current to pass.

As an example of the first method, a steering gear and rudder indicator may be mentioned, which are constructed on similar lines, the indicator being, so to speak, a working model of the steering gear. A shunt-wound electric motor replaces the usual steam-engine, and turns the main shaft of the steering gear backward and forward by means of clutches, which are actuated by currents sent from the bridge. The current through the magnets actuating the clutches is interrupted automatically by the movement of the rudder-head, and a new impulse is wanted from the bridge before the steering gear will move again.

For the convenience of the quartermaster, the contact-making apparatus on the bridge is designed in the usual shape of a small steering wheel, so that it does not differ externally from the wheel used with steam-steering apparatus. On the rudder-head a similar contact apparatus is fixed, which controls the solenoid clutches of the rudder indicator on the bridge, which is, as stated above, a working model of the steering gear, and shows the quartermaster the exact position of the rudderhead.

Such an indicator has been in use on the s.s. *Faraday* for some time, and has given complete satisfaction, so that it is contemplated to substitute the corresponding electric-steering gear for the present steam-steering gear as soon as room can be found for larger generating plant.

Here, again, appears an obstacle to the introduction of electric motors on board, and it can only be overcome by designing the engine-rooms for the accommodation of powerful electric generating plant.

There is every indication that this requirement is now being fully recognised, and that in future it will be possible to utilise electric motors in connection with all auxiliary machinery, and the absence of all pipework outside the engine-room and boiler space will greatly increase the safety and convenience of working ships.

Sometimes it has been suggested that the main engines of a transatlantic liner should also be worked by electricity, either on the plan adopted by Mr. Heilmann, for locomotives, or by means of accumulators. Although this may seem feasible at first sight, our present knowledge is not sufficiently advanced to make a practical test of either suggestion. Marine engines are the lightest per horse-power that are constructed; it would, therefore, not be possible to put smaller engines on board to generate electricity than those now used to drive the propellers direct. It is, therefore, self-evident that the Heilmann system cannot be economically applied for the main engines of ships.

Equally impossible would it be to use accumulators for driving electric motors connected to the propeller shafts, as their weight would greatly exceed the capacity of the ship. This is easily shown by the consideration that a 6,000 tons ship, propelled by 8,000 indicated horse-power, will take about 150 hours to cross the ocean, equal to 1,200,000 horse-power hours. Fairly efficient accumulators give about 10 watt hours per 1 lb. of their weight, so that a horse-power hour can be obtained for 75 lbs. of accumulators. The ship in question would, therefore, have to load about 40,000 tons of accumulators for the trip across the Atlantic.

No doubt there are further discoveries in store which will enable future electricians to attack the problem of propelling large ships electrically for long distances; for the present, it has only been proved to be an advantage to drive electrically the auxiliary machinery on board ship.

*INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.**

Prior to the year 1800 little was known of the properties of the materials of construction. Galileo had shown in 1638 that the strength of a rectangular beam varied with the square of its depth, Hooke in 1678 had announced the law that the stretch of a spring was proportional to the stress upon it, various authors had discussed the forms of beams of uniform strength, and Euler in 1744 had enunciated his formula for the resistance of columns under compression. Theory was far in advance of practice, for experiments had been so few and so imperfect that the elastic limit was scarcely recognised.

During the years from 1800 to 1850 great progress was made in the theory of elasticity, and a slow growth took place in knowledge of the properties of materials under stress. The methods of testing were, however, imperfect, and progress was slow, and, with the exception of the classic researches of Hodgkinson, the work of this period was mostly of value as a preparation for that of the future.

In 1882, through the influence of John Bauschinger, a number of German experimenters met at Munich and discussed the question as to how uniformity in the methods of testing materials could be promoted. As a result of this meeting, formal conferences were held at Dresden in 1884, at Berlin in 1886, at Munich in 1888, and at Vienna in 1893, delegates from other European countries being often present. The reports of the proceedings of these conferences, published in Bauschinger's "Mittheilungen," attracted wide attention, and the great value and importance of the discussions became universally recognised in engineering circles. In short, the movement assumed an international character.

In 1890, as a result of the International Congress of Engineering held at Paris in the preceding year, the French Government appointed a commission to formulate standard methods for testing the materials of construction. Its report, published in 1894, in four large volumes, is one of the most valuable contributions to the subject, but from the first it was recognised that ultimate conclusions could not be determined by a commission of one nationality, and accordingly, since 1895, the French Government has given hearty support to the work of the International Association.

In 1895, as a result of the four preceding conferences, the fifth conference met at Zurich, all European countries, except Turkey, being represented. At this congress the International Association for Testing Materials was formally organised, its object being, as stated in its statutes, "the development and unification of standard methods of testing for the determination of the properties of the materials of construction and of other materials, and also the perfection of apparatus for that purpose."

In 1897 the second congress of the International Association was held at Stockholm, there being present 61 members, representing 18 countries. The congress continued in session for three days; reports of committees were presented, papers read and discussed, and plans outlined for the future work. It was resolved that the next congress should be held in Paris in the summer of 1900, and the Council was authorised to appoint technical committees to make reports at that time on special problems relating to the objects of the Association.

At a meeting of the International Council held early in 1898 appointments were made of chairmen of 21 committees on technical problems, and the number of members on each committee from each country

* An address by Professor Merriman quoted in *The Iron and Coal Trades Review.*

was assigned. It was also recommended, in order to expedite the appointment and work of these committees, that the members in each country should meet and form a national section of the International Association.

The membership of the International Association numbered 493 in 1895, 953 in 1896, 1,169 in 1897, 1,488 in 1898, and is now probably about 2,000. Germany takes the lead in regard to numbers of members, it having 387 in 1898, while Russia had 315, Austria 158, England 83, Switzerland 83, United States 68, Sweden 68, France 66, Holland 48, Norway 42, Denmark 39, Spain 36, Italy 35, and 60 from nine other countries.

The subscriptions of 6s. per year transmitted to the International Council are used by it in issuing its publications, and in assisting its committees in defraying a part of the expenses of their special investigations. The detailed proceedings of the congresses have been printed in the journal *Baumaterialienkunde*, published in the French and German languages, at Stuttgart, which has been furnished to members at 10s. per year. It will be seen, therefore, that a member who desires to be fully informed regarding the work of the Association must necessarily subscribe to this journal.

The technical questions proposed for discussion at the Paris congress of 1900 are 19 in number. The organisation of the international committees which are to consider these topics is now complete. Probably the most important of these subjects is that of standard international specifications for testing and inspecting iron and steel; this committee originally consisted of about 40 members.

Of the nineteen problems to be considered by the nineteen international committees, six are on iron and steel, one on stone and slate, eight on cements and mortars, one on tile pipe, one on paints, one on lubricants, and one on the dry rot of wood. The fact that there are eight committees on cements and mortars and only six on iron and steel may seem abnormal, but it should be remembered that in the testing of hydraulic cement, the personal equation of the observer enters to a far greater degree than in the case of metals, and that its rapidly increasing use demands the immediate perfection of methods which will render comparable the work of different laboratories.

While the main object of the Association is to establish rules for testing, it is recognised that this cannot be done until a thorough knowledge is obtained of the properties of materials under varying conditions. Accordingly, the work of some of the committees is to collect and digest the information now on record, or to make scientific investigations that will render present knowledge more complete and definite. Thus, there is a committee on the properties of steel at abnormally low temperatures, one on the relation of the chemical composition of stone to its weathering qualities, one to digest the work of previous conferences and conventions on the adhesion of hydraulic cement, one on the causes of the abnormal behaviour of cements as to time of setting, and one on the protection of wood against dry rot. Some of these subjects have already been discussed at the congresses of Zurich and Stockholm, and accordingly the reports to be presented to the Paris congress should contain positive additions to present knowledge.

There are advantages and disadvantages in doing technical work by committees. One advantage accrues through the harmonisation of the different views held by individuals, whereby non-essentials are rejected and only fundamental methods are retained. One of the disadvantages is that this process of harmonising views takes time, causing reports to be long delayed, particularly with international committees. Some technical societies appoint committees with great reluctance, fearing that their reports may be regarded as official action. In the case of an international organisation, no such fear is felt, and the report of a committee is to be considered from the same point of view as the paper of an individual member. Through the formation of the national sections, the work of the international committees can certainly be made more valuable and effective than ever before, for each national sub-committee, after having eliminated disagreements of its individual members, can work as a body to impress its views upon the other national sub-committees. In many cases an international agreement may be found difficult to make, but if made after such full discussion it will be sure to be authoritative and valuable.

The subject of the chemical analysis of iron and steel has been discussed in previous conferences and congresses, and at the Stockholm meeting of 1897 it was formally resolved to establish an international sidero-chemical laboratory at Zurich. It is, however, to be doubted whether the establishment of chemical and physical laboratories falls properly within the scope of the objects of the Association. If sufficient funds could be raised so that men of different nationalities might meet at such a laboratory to actually make analyses and tests, each criticising the others, while at the same time learning from them, then undoubtedly effective work would be done in harmonising differences and perfecting standard methods. It is to be hoped, if the establishment of the sidero-chemical laboratory at Zurich proves to be successful, that it may tend to further this method of research. It is, however, the opinion of many members that results as good, if not better, would be secured by arranging systematic schemes of investigation, and distributing the actual work of analysis or testing among the laboratories of different countries.

THE VIENNA EXPORT ACADEMY.

Since October, 1898, there has existed in Vienna a commercial school of an entirely original organisation. This is primarily shown from the fact that the institution is directed by a high official of the Austrian

Ministry of Commerce. This direction is not merely nominal, but is evidenced, apart from daily influence on the life of the pupils, by weekly conferences, under the chairmanship of the director himself, at which reports are received from the teachers of the studies of the past week, and those to be taken up in the coming ones. Every topic, even in its smallest details, is in direct relation to the object of the institution. This object is the promotion of the Austrian export trade. No serious patron of the academy wishes that the young men, immediately after finishing their studies, should become Austrian exporters. On the contrary—and this is the second original phase of the scheme—it is desired that the graduates, on leaving the academy, should act as clerks in exporting and manufacturing firms, there to learn the practice of some special branch of business, whereupon, under further support of the Ministry of Commerce, the graduates are to be placed with larger foreign firms; and, finally, by joint protection of the Austrian Government, the Chambers of Commerce, and the particular foreign consulate concerned, they will be aided to establish themselves abroad. According to a recent report of the United States Consul at Vienna, the academy has a preparatory course of one year, and a regular course of two years. Further, there are special courses of greater or less duration. The tuition fee is 150 florins (£12 10s.) a year. The pupils are given the opportunity to occasionally visit, under the supervision of thoroughly informed teachers as guides, the prominent industrial establishments of all typical export articles, as well as certain commercial cities and ports of special importance. Thus, for instance, an excursion to Hamburg is planned, while trips to mills, sugar refineries, breweries, and furniture factories are undertaken. The Imperial Royal Commercial Museum, of which the export academy has been made an integral part, has placed at the disposition of the academy its library, its valuable trade collections, and the requisite geographical maps and apparatus. The academy has a yearly subvention from the Ministry of Commerce of 20,000 florins (£1,666), and a like sum was to be raised by popular subscription. First of all, graduates of the higher commercial schools are entered as regular students in the academy. Further, pupils are admitted who have passed the grammar schools and possess such knowledge of commercial branches and of the French and English languages as can be acquired in a commercial school of two classes. All desiring to be admitted as regular students must pass a preliminary examination. In exceptional cases pupils who have completed their studies in an unusually excellent manner in a commercial school, and can produce testimony of already having done praiseworthy work of a practical kind, may be admitted as regular students by the faculty without preliminary examination. This rule of exception has already been applied in many instances, and gives the academy some of its most promising pupils. Two groups of students can be plainly distinguished—those with and those without practical experience. In no class o[f] the academy are more than thirty students admitted and only twenty in the preparatory course. The actual number of pupils at present is near the maximum allowed. Attendance at the classes and lectures of the export academy is compulsory and subject to strict supervision. An absence of eight days without proper justification is followed by striking off the student's name from the roll. This is another distinguishing feature of the school, wherein it differs from all other Austrian and German high schools, and recalls the Paris "Ecole des Hautes Etudes" as well as French schools in general. At Christmas and Easter in each year, oral examinations are held in all the branches of study. During the first year, the annual examination takes place in the first half of July. The regular students have to undergo a severe final examination at the close of the second year before a board of examiners, presided over by a representative of the Ministry of Commerce. The names of students who do not pass one oral examination without good excuse are struck off the roll. In some cases the board of examiners may permit the repetition of a year's course or of the severe final examination. Only those students are admitted to the second year who have favourably passed the annual examination in all branches of the first year's course. There are thirty-four hours weekly in the preparatory course, and in the first year thirty-four or thirty-five obligatory hours every week, besides some that are not obligatory. The preparatory course has for its purpose to advance graduates of gymnasia about as far in one year as an ordinary commercial school does in two or three years. Of the two yearly courses of the academy only the first has so far been opened, and the students have in all the examinations up to the present given brilliant evidence of the excellent curriculum. In this course great stress is laid on the study of the French and English languages, with practice in correspondence (six hours each, weekly). Four hours a week are devoted to domestic and foreign law, so far as it concerns commerce. Three hours are given to practical exercises in the office work of export, import, and factory businesses. Instruction in this important branch is entrusted to the assistant-director of the academy. In view of the burden entailed by the large number of school hours, home time is demanded only for languages and office lessons. Instruction in economics, with special regard to tariffs, in the usages of export trade, in commercial geography, and on knowledge of the world's wares according to kind and production, is imparted in so-called seminaries—that is, institutions which afford immediate practice of what has been learned from the teacher's lecture, and, so far as possible, actual inspection of the modes of production and of samples. Consul-General Hurst is of opinion that this experiment of "giving the pupil the most important facts in the school, instead of letting him learn by heart what he is sure to speedily forget, and to have hi[m]

practice it on the spot until indelibly engraved on his memory, is one of the most daring as well as important innovations, and deserves to be imitated." Besides all this, lectures on selected subjects of actual interest are given by professors of the export academy, by manufacturers in the various industries, and by Government officials, and are attended voluntarily by the students, who display deep interest in them. In this manner they become acquainted with special questions of the day that are engrossing public interest, in a manner that is unbiassed by party standpoints.

KEW GARDENS.

The following historical notice of the Royal Botanic Gardens, Kew, from the "Colonial-office List" for the present year, is quoted from the *Kew Bulletin* :—

"Kew as a scientific establishment dates from 1759, when a Botanic, or, as it was then called, a Physic, Garden was established by the Princess Augusta of Saxe-Gotha, Dowager Princess of Wales.

"It was energetically maintained by her son, George III., with the scientific assistance of Sir Joseph Banks, who was virtually for the greater part of his life director. Under his advice, collectors were sent to all parts of the world. The first New Holland plants were introduced during Cook's voyages, 1768 to 1780. At Sir Joseph Banks's instance the system of inter-colonial exchange was commenced, which has been maintained ever since. The most memorable undertaking of this kind was the voyage of the 'Bounty' (1787) for the purpose of introducing the bread-fruit tree from the South Seas into the West Indies. Nelson, the Kew collector, was amongst those sent adrift by the mutineers, and eventually died of the exposure. Another Kew gardener, James Hooper, who had been attached to Lord Amherst's Embassy to China, remained in Java, and was from 1817 to 1830 Hortulanus of the celebrated Dutch Colonial Botanic Garden at Buitenzorg, which he helped to create.

"Both George III. and Sir Joseph Banks died in 1820, and the colonial and other work of Kew languished, though it was not absolutely abandoned, during the reign of George IV. and William IV. In 1838 the abolition of the whole establishment was contemplated by the Government. Public opposition led to the appointment of a Treasury Committee, the report of which was presented to Parliament in 1840. The following paragraphs briefly defined the functions of the reorganised establishment :—'A national garden ought to be the centre round which all minor establishments of the same nature should be arranged . . . . From a garden of this kind, Government would be able to obtain authentic and official information on points connected with the founding of new colonies; it would afford the plants there required without its being necessary, as now, to apply to the officers of private establishments for advice and assistance.'

"These recommendations having been adopted by the Government, Sir W. J. Hooker, F.R.S., was appointed director in 1841 to carry them out. A close connection between Kew and the Colonial-office immediately sprang up. A scheme for a complete series of colonial floras was sanctioned in 1856, and has been steadily prosecuted. Kew serves, to a large extent, as an advanced horticultural school. Special attention is given to the preparation of gardeners for colonial service. Some sixty men, trained at Kew, are now in official employment in different parts of the empire.

"Relations with the botanical institutions of the self-governing colonies are maintained by semi-official correspondence. With those of colonies more directly under the control of the Colonial-office, the connection is closer.

"Colonial botanical institutions fall roughly into three classes. Those of the first-class are usually, like Kew, administered by a scientific director (Sir W. T. Thiselton-Dyer); those of the second-class by a skilled superintendent; the third-class consists of botanic stations. These last are small and inexpensive gardens, devised in 1885, in order to afford practical instruction in the cultivation of tropical crops, and were intended to develop the agricultural resources, at first, of the smaller West Indian Islands, and subsequently (1887) of British possessions in tropical Africa. Each is in charge of a curator, who is a gardener trained at Kew.

"The most important colonial botanical institutions in intimate relation with Kew, are the Gardens at Ceylon, Straits Settlements, and Jamaica.

"In 1898, in accordance with the recommendations of the West India Commission, a Special Department of Agriculture was created for Barbados, the Leeward and the Windward Islands, and was placed under the charge of a Commissioner (Dr. D. Morris, C.M.G., M.A.), with headquarters at Barbados."

*THE SOUTH-EASTERN COAL-FIELD.**

The discovery of the South-Eastern coal-field is of great practical value, as it will probably result in the same development in Kent of industries and manufactures which has taken place where the coal has been worked, under the same conditions, under the cretaceous and jurassic rocks in France and Belgium. It is of equally great theoretical value, as it proved the truth of Godwin-Austen's view, published in 1858, that the coal measures lie buried underneath the newer rocks in South-Eastern England.

The first boring to be noticed was at Ropersole, a spot near the highway between Dover and Canterbury—eight miles from Dover, at 400 ft. O.D.—the

* Abstract of paper read by Prof. Boyd Dawkins, F.R.S., at the Dover meeting of the British Association.

surface being composed of upper chalk, with a thin stratum of clay-with-flints. It was begun at the close of 1897, and had at the present time pierced the strata to a depth of 1,773 ft. 7 in. In the author's opinion the coal measures of Ropersole were a portion of the same series as those at Dover. Here, as at Dover, the question of seams of coal resolved itself probably into a question of sinking deeper. Here only two unimportant seams have been met with in a thickness of 197 ft. There 12 seams were penetrated in a thickness of 1,054 ft. 6 in., the thickest 4 ft. seam being at the bottom. The Ropersole boring established the fact that the Dover coal measures extended northwards for a distance of eight miles and beyond in the direction of Canterbury. The coal measures set in in Kent at a sufficient distance to the north-east of Brabourne to allow of the presence of the carboniferous limestone and millstone grit. These probably dip at the same high angle as the Devonian below.

Their south-western boundary could only be accurately defined by further borings, such as those which were now being carried on at Ottinge, about two and a half miles to the north-east of the scarp of the Downs, and six miles to the south-west of Ropersole. Their range to the north and the east still remained to be proved. They were, however, continued under the Channel, as had been proved by the boring at Calais in 1850 as well as those carried out in 1898 at Strouannes, near Wissant. In this district they were clearly shown by other borings to be faulted into the Devonian and other pre-coal-measure rocks. The thickness and value of this south-eastern coalfield could only be estimated by the exposed coalfields of northern France and Belgium, and of Somerset. That of Liége was 7,600 ft. thick and contained 85 seams, presenting an aggregate thickness of 212 ft. of workable coal. That of Mons was 9,400 ft., with 110 seams yielding 250 ft. of coal. In Somerset the coalfield was 8,400 ft. thick, the seams were 55 in number, and yielded 120 ft. of available coal.

It was obvious from these figures that the possibilities of the south-eastern coalfield were very great, although it still remained to be proved how far these great thicknesses of rock had been denuded in Kent before the deposition of the triassic and jurassic rocks.

To sum up, the results of these borings were likely to bring about the same economic revolution in Kent as was brought about in France by the extension of the coalfield of Valenciennes and Mons, about ninety-five miles to the west of its original outcrop at the surface, and to within some thirty miles of Calais. The coalfield had been proved at Dover. Its range for eight miles to the north had been also proved at Ropersole. Its southern boundary, as yet ill-defined, was marked by the Pembroke-Mendip anticline, ranging under the southern scarp of the chalk downs. Its range in other directions was unknown, and awaited further investigation. To the south of this anticline the palæozoic floor was probably composed of pre-coal-measure rocks. If, however, the coal measures did occur, they were buried under such great thicknesses of superincumbent rock—largely sands and loams full of water—that it would be difficult to work them.

They knew now by experiment, not only where to seek, but also where it was advisable not to seek, for the coal measures. The difficult problem of the buried coal measures in South-Eastern England, now being worked out by private enterprise, was likely to add greatly to the resources of this country, as it had already added to the wealth of geological knowledge.

In the discussion that followed the reading of the paper, Professor Dawkins said further that there was good blazing coal, as well as steam coal and anthracite, found in South Wales, exactly corresponding to that of Dover; that he had found no lignite in the Dover coal measures, but some in the secondary rocks, the oolites, above; that no temperature observations were possible in the borings; and, finally, in respect of the depths of the coal measures, that he was of the opinion that the seams reached at Dover formed only the upper part of the measures, so thick at Westphalia, where they were 7,200 ft. thick, and reached 7,600 ft. at Liége.

THE PRODUCTION OF RUBBER IN THE AMAZONS.

The principal rubber-bearing areas in the State of Para are the islands of the River Amazon near the city, the principal, Marago, having an area of 2,500 square miles; the banks of the river Tocantins; the banks of the rivers Zingu, Jary, and Tapajos. The upper and lower districts of the Amazon produce the same kind of rubber, but that coming from the upper river obtains a slightly higher price, being dryer by the time it reaches the port of shipment.

The collecting season for rubber in the Lower Amazons begins when the waters have subsided—about July—and ends in January or February. Collecting is not undertaken, as a rule, in the wet season, because the quantity of water that accumulates in the forest impedes the movements of the collectors, and the rain water that runs on the trunks of trees prevents the clay cups from adhering to the bark. The sap is also weaker in this season. The United States Consul at Para, in a recent report, says that the collectors employed are principally Brazilians, immigrants from the States bordering on Para, such as Ceara, Maravham, and Piauhy, also Portuguese and half-castes. The pure South American Indian is of very little use as a labourer. He has but few wants, lives by fishing and hunting, and is less dependent on labour than more civilised people. There are many thousands of collectors in the rubber field, yet the number does not supply the demand.

The last few years have shown a steady and rapid increase in the exports of rubber, and while labour has also gradually increased, it has failed to keep pace with the fast-growing demand. Among other

articles used in the india-rubber industry is a clay funnel, in shape very much like an ordinary toilet water-jug without a bottom or handle. It is made of the clay that is found in most parts of the Amazon region. The fuel used in the funnel consists generally of the nuts of the following palms:—Native name—"Urucuri," "Tucuma," "Inaga;" botanical name — *Attalea*, *Astrocaryum*, and *Maximiliana regia*. It was at one time imagined that the excellence of Para rubber was greatly due to the kind of fuel used in curing it. The palms that furnish the fuel were accordingly transplanted to Africa, with a view to the production of Para rubber there. The experiment, however, has not met with success. The reason these nuts are selected in Brazil is because they emit a continuous dense smoke, and are more portable than other fuel obtainable. However, when none of the palms named are accessible, bark and twigs are used as fuel.

Everyone engaged in the forest carries a knife. One of its uses is to cut down fuel for the preparation of rubber. The blade is about 26 inches long, and about 2 inches broad. Owing to the damp climate, the blades are electro-plated, thus preventing their becoming rusty before they are marketed. The handles are made of wood, and are carved or inlaid with brass. The rubber collector's axe is a very small affair. It is required to chip a smooth surface on the bark preparatory to attaching a cup to the tree. The handling of the axe requires great skill, in order not to injure the bark. A smooth surface is made in order to prevent impurities from mixing with the sap. The cups are of clay or tin. The former are attached to the bark by means of a little clay. Their weight, however, makes them inconvenient to carry when the trees to be tapped are separated by long intervals; the collector then prefers to carry tin cups, which are much lighter than the others. They easily penetrate into the bark by means of their sharp edges, and hold to the tree without the use of clay. The use of the tin cup, however, is to some extent injurious to the tree.

Part of the collector's outfit consists of a light gourd, large enough to carry the contents of from 500 to 700 cups. A clay bowl is next required in order to receive the contents of the gourd. It is of sufficient size to contain the product of several days' work before it is cured. The calabash tree provides calabashes which are employed to ladle the milk from the clay bowl into the mould. A broad-bladed wooden paddle is used as a mould, and is made locally. This completes the outfit for the rubber collector. All these articles are made locally, with the exception of the knives. The axes and the tin cups are manufactured in the towns and villages of the Amazon region. The collector has to use his knife to cut his way through the undergrowth, and also to cut down a sapling occasionally to bridge a rivulet. At times he is knee-deep in ooze or up to his waist in water. On arrival at a rubber tree, he chips away the rough parts of the bark, makes a more or less smooth surface, attaches a cup and makes a small gash above for the sap to fall into the cup, and repeats this process in a line round the tree until he has attached six or seven cups. Then he proceeds to the next tree and does the same. He continue this process until he has tapped from 75 to 150 trees, which can be done in a day, if they are not too far apart. On the following days, the gashes in the trees are made a trifle lower down than the first ones. Some collectors tap the trees in the morning, and return to collect the sap in the evening, whereas others tap in the evening, and collect in the morning. An expert gathers 7 pounds daily in the Lower Amazon; in the Upper Amazon three times this amount is collected. When the accumulated rubber is sufficient—usually in three or four days—a collector lights a fire in the hut he has erected, places the funnel over the fire, pours a thin coat of milk over the paddle, and holds it over the smoke to coagulate. The process is repeated until a large cake has been formed. To release the paddle from the cake, it is necessary to make a slit on one side. The paddle mould makes a cake of uniform and even shape, and is in general use in the State of Para. In other parts, a spit is placed on two upright forked sticks, and given a rotary motion. By this means, the rubber is cured with greater ease. Paddle-smoked rubber is decidedly preferred, as it is dried and seemingly more carefully cured.

Many attempts have been made to introduce improved curing apparatus. Up to the present, however, the efforts have not been successful, because the common method, although very primitive, possesses the advantage of being simple and inexpensive. The process of curing rubber is found to be very injurious to the eyes. Many cases of total blindness result from it. There are three grades of Para rubber, viz., fine, medium, and coarse. If rubber is not uniform, and contains impurities, it is classified as medium. The coarse quality, or "Sernamby," consists of scraps that have not been cured. Insufficient labour is the most serious difficulty in the rubber industry. Consul Kenneday says that it would scarcely seem advisable to invest money in rubber estates unless the owner can first see his way clear to obtain sufficient labour with which to collect the rubber.

ARTIFICIAL TEXTILE FIBRES.

The following abstract of Mr. W. M. Gardner's opening lecture of the winter session in connection with the chemistry and dyeing department at the Bradford Technical College is taken from the *Textile Mercury*:—

After describing the peculiarities of the three natural fibres, wool, cotton, and silk, Mr. Gardner said that if the structures of the three were contrasted it would be seen that wool and cotton possessed a highly-organised or cellular structure, whereas silk, being merely a

solidified liquid, had no special interior formation, thus resembling a thread of glass. It was therefore obvious that as regarded structure the silk fibre offered a much more promising field to the chemist who attempted its artificial reproduction than did the highly-organised wool or cotton. Given the requisite liquid it would not be an insoluble problem to produce from it a fibre resembling silk in every respect. On the other hand, it was hopeless to expect that an artificial fibre possessing the same internal structure as wool or cotton would ever be produced. No chemist had hitherto succeeded in reproducing the simplest body which exhibited a cellular structure. As regarded the chemical structure of the fibres they found that cotton was the simplest in composition. Most of the artificial fibres were produced from cellulose as a basis, and thus were chemically more closely connected with cotton than with wool or silk, but one or two were obtained from gelatine, and thus approximated to silk. In appearance, however, they all, without exception, resembled silk rather than wool or cotton. The first attempts to produce a valuable fibre artificially consisted in dissolving waste solvent, and then saturating cotton yarn or thread in this solution, thereby greatly increasing the lustre. Mr. Gardner proceeded to mention a number of commercially valuable products formed by various reagents on cellulose, and similar to some of the artificial fibres in composition. Collodion silks constituted the ordinary "artificial silks" of commerce at the present time. The name, "lustro-cellulose," had been proposed for these products, but had not been generally adopted. It was proposed in 1894 to manufacture this product in England, and Bradford would in all probability have been fixed upon but for the fact that the heavy tax on alcohol in England rendered any manufacture in which it was largely used expensive. The works were, therefore, established near Zurich, but the company had an office in Bradford. The manufacture of art silk by the processes he had described might be considered as consisting in the solution of the cellulose, followed by its regeneration in the form of a fine thread, the increased lustre of the new fibre being due to its smooth external surface. Dealing with the action of reagents on cellulose, the lecturer said that the action of alkalis was not less interesting than the action of acids, since by the aid of alkalis several most important fibres, mercerised cotton, and several forms of viscose silk were obtained, as well as many other useful substances. The applications of the ordinary mercerising process were (1) to increase the affinity for dyes, (2) to produce crepon on cotton, (3) to produce crepons on wool, cotton, or silk-cotton unions. Now, it was possible to contract either the wool or the cotton in a mixed fabric. The most important outcome of the mercerising process, however, was the observation that by mechanically preventing the shrinkage which naturally occurred during the process, a greatly increased lustre was imparted to the cotton. By this simple modification of a fifty-year-old process, the textile industries had been enriched with what was practically a new fibre, which approached silk in lustre, but which was infinitely cheaper. He did not propose to embark upon the stormy seas associated with a discussion of the patent rights in connection with this process. Only during the last five years had it reached importance, but its enormous development, due largely to the skill and enterprise of the Bradford dyers, had been such that several thousand pieces of cotton cloth were lustred per day in that district, in addition to enormous quantities of hank and warp yarn. The magnitude of the trade was emphasised by the fact that, possibly for the first time on record, the value of the cotton material exported to the United States from the consular district of Bradford had, for the four months ended August 31st, exceeded that of the dress stuffs, and was four or five times as great as the value normally exported during the same period. This was mainly due to goods lustred by mercerisation.

General Notes.

CHAMPAGNE PRODUCTION.—The Rheims Chamber of Commerce has just published the official statistics of the output of champagne, from which it appears that the amount for the year 1898-99 was over 106,000,000 bottles. This is less than the total for 1896-99—over 111,000,000 bottles, but the total for 1893-94 was under 87,000,000 bottles.

FRENCH INDUSTRIAL PRIZES.—Among the prizes offered by the Société d'Encouragement pour l'Industrie Nationale, open to all the world except members of the Society's Administrative Council, and that will be awarded next year, are the following:—Two thousand francs (£80) for a publication useful to the chemical or metallurgical industry, a treatise on metallurgical chemistry summarising the works that have appeared on the subject during the last twenty years being invited; two prizes of 500 francs (£20) each for scientific chemical researches the results of which are useful to industry, the authors not being required to have realised the practical applications which they may foresee as resulting from their observations; 200 francs (£80) for the scientific study of an industrial process the theory of which is still imperfectly known, the methods that permit of obtaining a given result being often known long before the nature of the phenomena is suspected, and yet the knowledge of which has great interest as regards reducing the number of empirical trials necessary for realising fresh improvements; and 3,000 francs (£120) for the production of permanent magnets, the qualities expected from which are power and stability. The models, papers, descriptions, &c., must be sent in before 31st December to the Secretary of the Société d'Encouragement, 44, Rue de Rennes, Paris.

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CANTOR LECTURES.

THE MANUFACTURE OF LEATHER.

By Prof. Henry R. Procter.

Lecture I.—Delivered April 17, 1899.

The manufacture of leather is a typical instance of a trade of great antiquity, which has attained a high degree of development by purely empirical methods, but of which the science is still very young. In such cases, the first aim which the technologist must set before him is to explain and understand the underlying reasons of the processes to which experience has led; and not till this is fairly accomplished can we expect to rival the brilliant success which science has scored in newer, and, in many cases, simpler trades.

For this backwardness the chemist is not wholly to blame. The earliest glimpse which we have of prehistoric man shows him as a hunter, whose first impulse in the colder climates must have been to clothe himself in skins. Skin, however, is not to be worn without preparation. Left moist, it goes quickly to decay; and, dried, it becomes hard and horny, and impossible even as the most primitive kind of clothing. The emollient effect of fat must have been felt on his own hands by the first man who handled raw meat, and the suggestion to rub it into the moist skin to keep it soft must early have occurred to him. This, combined with stretching and suppling with the hands, is sufficient to convert it into a sort of leather, and the method is in use to this day by savage races in every continent of the world. Even in England the furrier employs methods on his finest furs which differ from it in detail, but not in principle. Later on, the preservative effect of smoke would be surely noticed in houses without chimneys; the action of alum would be observed in some cases where it had been accidentally or experimentally substituted for salt, in lands where it effloresces as a natural product; and the effect of vegetable tans may perhaps have been discovered in some primitive attempt at dyeing by the aid of barks or seeds. Certain it is, that even in the earliest historical times, the art of leather manufacture had reached an advanced stage; and specimens of dyed and gilded moroccos from the time of the Pharaohs still exist, not perhaps inferior in appearance to the leathers of the present, for which few would venture to claim a similar durability.

The difficulty of the chemist, however, does not arise alone from the immense amount of empirical knowledge accumulated in this oldest of trades, where almost every conceivable device has been tried; but yet more from the fact that the science involved belongs in almost every case to the most obscure and difficult branches of chemistry and physics. The structure of animal skin is very complicated, and the chemical constitution of its components is yet unknown. The molecular weight of its principal, and probably its simplest constituent, gelatine, is on the least computation near 2,000, and may be much more; and of the vegetable tannins it cannot be asserted that the structure of any single one is clearly understood. Add to this that the physics involved in the swelling and osmotic absorption of colloids, and you have a series of problems calculated to tax the knowledge of the best chemists who exist; and, it is needless to say, quite beyond the scope of the simple physics and inorganic chemistry of the earlier part of the century. The result is, that while the mechanical treatment of very difficult materials is extraordinarily perfect, the chemistry and physics of the subject are mostly yet to make, and few more promising fields, both as to scientific interest and practical result lie open to the technical investigator.

The raw material of the trade is extremely varied, ranging from the thinnest kid-skin to the stoutest ox-hide, and the purposes to which leather is applied are innumerable. With such a range of material and requirements, the modes of treatment are necessarily numerous, and it would be impossible in the course of four lectures to explain them in any detail. Fortunately a similarity of structure of the material, and of principle in its manufacture, runs through the whole group, and having once mastered this, it becomes possible to grasp the reasons for variation in the details, even when that variation is so great that at first sight

the processes seem to have but little in common.

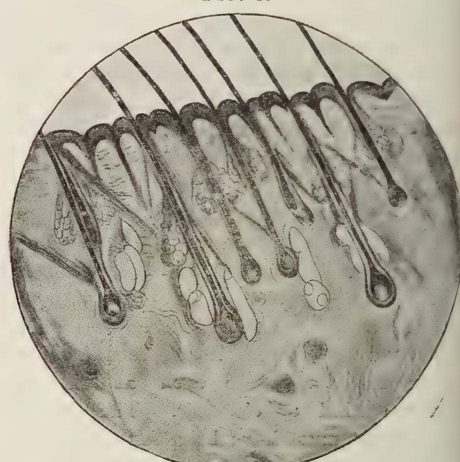
Naturally, the principal material of the trade is derived from the skins of domestic animals killed for our food by the butchers; ox and cow hides, and calf, sheep, and lamb skins. These are mostly delivered at the tanneries as they are taken from the animals, in a more or less fresh condition. But in addition to these, we draw supplies in enormous quantities from distant countries, which, of course, have to undergo some form of curing to render their transmission possible. Near the sea, and in civilised lands, salt is the material usually employed, and it answers its purpose on the whole effectively and well. The preparation of such hides is seen at its best in the great slaughtering and packing establishments of Chicago and St. Louis. The hides are removed systematically from the animals without cuts or damage, and with little adhering flesh, and are spread out in cellars, in piles of perhaps 20 feet square and 5 or 6 feet high, salt being plentifully sprinkled on each hide. After lying in this way for about a fortnight, the salt is shaken off, and the hides are tied up in bundles for delivery. Similar methods are adopted in the great saladeros of South America, such as "Liebig's" at Fray Bentos. Further inland, on the pampas, where the cattle are reared, the cost of salt is too high, and the weight of wet salted hides too heavy for transport on the backs of mules, and simple drying is resorted to. This should be done under protection from the sun, which in some cases is hot enough to convert the interior of the hide into glue after evaporation is checked by surface drying; but, unfortunately, this precaution is not always adhered to. Damage to dried hides also often takes place by putrefaction in the interior after surface-drying, and unfortunately such injuries cannot be detected until the hides have been softened and limed, when the damaged part dissolves, and the hide blisters or breaks into holes. To avoid these injuries, salting and drying are often combined, and such hides are known as "drysalted."

A somewhat interesting process of this sort is applied to many of the hides of the small cattle of India, known in the trade as "East India Kips." Salt is scarce and dear, and in several districts a natural salt earth is used for curing. This is made into a paste with water, and rubbed repeatedly into the flesh side of the kips with a soft brick while they are being dried. These cures are called "plaster cures," since the earth is white and more or less calcareous, and when dried has almost the appearance of whitewash, and of course adds considerably to the weight of the hides. It is rather singular that these earths contain scarcely a trace of sodium chloride, but principally sodium sulphate with a little carbonate and some ferric oxide. The latter, being insoluble, has no injurious effect on the hides if dried quickly, and kept dry, but if exposed to moist air for a lengthened period, a portion is converted into hydric ferrous carbonate, which dissolves and produces stains, and these are a serious disadvantage to the tanner.

Goat skins, and sometimes sheep and calf skins, are preserved by drying, while sheep skins, after being deprived of their wool, are frequently treated by a process known as pickling, which will be more conveniently considered in a later part of the course.

All the skins of which I have spoken, though they are characterised by differences of thickness and texture, are anatomically so similar, that their structure may be considered together.

FIG. 1.



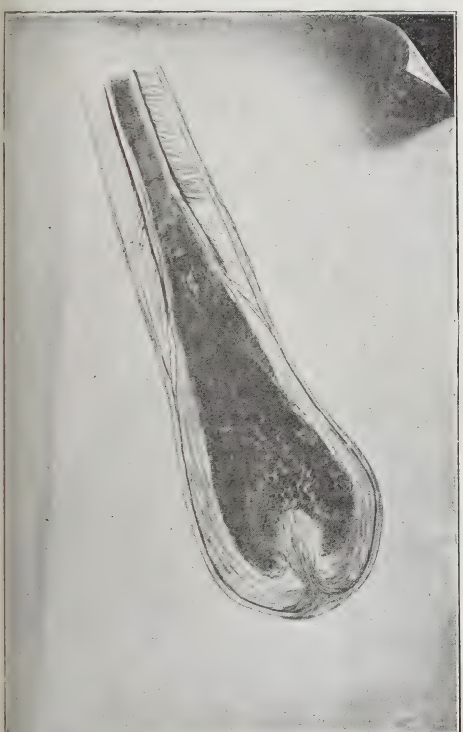
SECTION OF CALF SKIN, SHOWING HAIRS AND SEBACEOUS AND SUDORIFEROUS GLANDS.

The skin is much more than a mere covering for the animal: it is a complex organ of secretion and sensation. In all mammalia it has two principal layers which are not only very distinct in their structure, but in the chemical character of the materials of which they are composed. This difference of structure corresponds to a difference of origin which dates back to the first few hours of the development of the germinal cell, which as it multiplies by division, rapidly forms an upper, a lower, and a middle layer. From the upper of these is

developed the epidermis or outer skin with its appendages, hair, horns, nails, hoofs, and the like; the middle layer furnishes all the bony and fibrous structure of the body, of which the true or inner skin forms a part; while the lower layer supplies the epithelial lining of the internal organs, which in structure closely resembles the epidermis.

Although the various structures which have been named as arising from the epidermis are very different in their outward appearance, they are all constituted of simple animal cells, differing only in shape and size, and secreting cell walls of keratin or horny matter, a substance, or perhaps a class of substances, which is nearly allied chemically to the coagulated albumen of a hard-boiled egg.

FIG. 2.

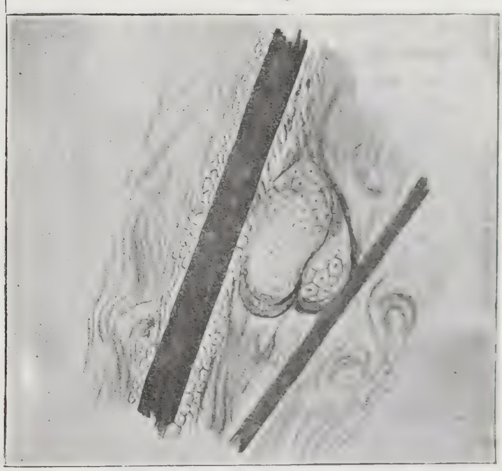


HAIR BULB, SHOWING PAPILLA, AND INNER AND OUTER ROOT-SHEATHS.

As the epidermis is unprovided with blood-vessels, its growing cells can only derive their nourishment from the lymph of the true skin on which they rest, and hence only in the innermost layer can active growth take place. They multiply, as is usual with cells, by increase of size, and division both of the cell and its enclosed nucleus so as to form two complete cells. As the lower layer increases, it pushes away the older and outer cells from their source of nourishment; these flatten, dry up, and die, and form the outer surface of the skin, whence they are removed by friction or washing, or where they are protected by the hair, separate in small flakes of scurf, which in moderate amount is a perfectly healthy and normal product.

The original development of the young hair from the epidermis layer is somewhat interesting. A knot of minute capillary blood vessels forms on the surface of the true skin. The epidermis cells, stimulated by the liberal nourishment which this provides, increase rapidly, and press down into the true skin, and partially surround the knob, which sinks deeper and deeper, and at last remains embedded in the bulb of the growing hair as its source of nourishment, and connected with the corium by a mere stalk. As this process goes on, the epidermis cells seated on the top, sides, and neck of this knob, which is called the hair papilla, become differentiated in character from those of the surface layer, and produce respectively the pith and cuticle of the hair, and the lining or "hair-sheath" of the tube of epidermis through which it grows. Near the neck

FIG. 3.



STEM OF HAIR, WITH SEBACEOUS GLAND AND ERECTOR MUSCLE.

of this hair-sheath a somewhat similar process goes on, resulting in the development of two or more small glands, or grape-like masses of cells, which take on the duty of producing within them a peculiar oil, which is discharged by ducts just below the neck of the sheath, and serves the purpose of lubricating the hair and

giving it its natural gloss. The replacement of old hair is very similar to what has been just described, the young hair originating below the old sheath, into which it usually grows. In a very similar way to the hairs, other glands, not unlike the oil or sebaceous glands just mentioned are produced, which secrete perspiration, and so serve the important ends of moistening the skin, and thus cooling the body, and of removing certain waste products from the blood. It is worth noting that these glands, of which the activity is readily effected by sensations, and especially by the emotion of fear, are apparently unprovided with nerves! Probably the effect is an indirect one and dependent on the surface circulation in the true skin, which is controlled by the sympathetic system. Perhaps it is also worth pointing out that warts and corns and such abnormal growths of epidermis tissue have much in common with the phenomena of the growth of hairs. Like them, they originate in an increased supply of blood to a particular spot, and warts at least are easily cured by touching them with nitric acid until the underlying knot of blood vessels is killed, when the wart immediately ceases to grow.

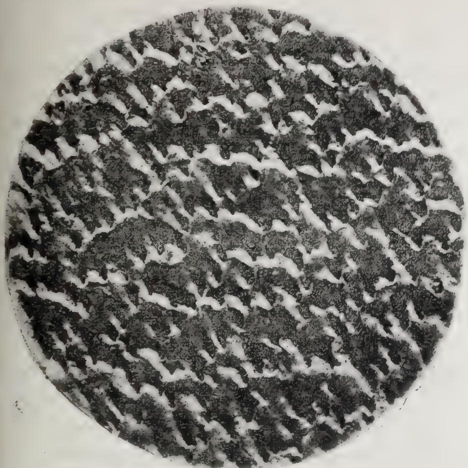
The structure of the true skin or *corium* is quite different from that of the epidermis which has just been described. In place of the layers of cells, with their keratin walls, we have bundles of fibres composed of a substance which scarcely differs from gelatine, and these fibres are not in themselves living cells, but are produced by narrow nucleated cells which lie among them. Instead of depending for nourishment on the liquids of the underlying layer, the true skin is abundantly supplied with blood vessels, and, unlike the epidermis, it is capable of feeling, and is indeed the organ of the sense of touch, the nerves of which terminate in its small projections or papillæ. Interspersed among the white gelatinous fibres are some yellow "elastic fibres" of quite different material, which form a sort of elastic skeleton to the skin, but are of little direct importance in the manufacture of leather.

The structure of the white gelatinous fibres is peculiar. It is generally stated that they consist of bundles of finer fibrils, tied as it were at intervals by yellow "elastic fibres," and cemented together by some gelatinous substance; but perhaps it would be more accurate to say that they are so constituted as to be readily split up into these finer fibrils by the action of solvents, since it is by no means clear that the so-called cementing substance is in any way chemically different from the fibres themselves. Both acid and alkaline solutions possess the power of swelling and splitting up the coarser fibres or fibre-bundles, at the same time dissolving a portion of their substance, and this dissolved substance continues of the same character even if the action is so long continued that it may be presumed that all soluble matter of a different character to the fibres themselves has been dissolved and removed. Towards the outer surface of the skin on which the epidermis rests and in which the hair roots are embedded, the fibre-bundles are naturally divided into these finer fibrils which are closely felted together into a compact layer which is often called the "grain." This word "grain" is used by the leather manufacturer in a variety of senses which is apt to become confusing. It is not only applied to the compact layer of tissue, of which I have just spoken, but to a thin film which covers it and separates it from the epidermis, and which is known to anatomists as the "hyaline" or glassy layer, and which remains as a sort of glaze on the finished leather. The word is also used not merely to express this material surface, but sometimes to describe the little projecting marking upon it formed either by the papillæ and hair pores, or artificially in the process of leather manufacture, and from these perhaps the word was originally derived, since in old times such markings were in some cases formed by pressing seeds into the surface of the leather. Thus a sheepskin embossed to imitate alligator or pigskin is said to have an "alligator" or "pigskin" grain, and so well is this done that even experts are sometimes deceived by it. It is, however, always easy by study of the arrangement of the hair pores with a lens to decide to what animal the skin belonged. The bristles of the pig and the fine wool of the sheep leave very different traces behind them. This may be readily seen in the photo-micrographs of various grains given in Figs. 4, 5, 6, and 7 (p. 831), for which I am indebted to Mr. A. Seymour-Jones.

While towards the surface of the skin, the fibre-bundles are as it were teased out and more closely felted together, they become a looser network in the middle portion, and again form a compacter structure towards the inner surface, though without any separation into the finer fibrils. The skin is attached to the animal by a looser network of connective tissue composed of the same white fibres as the skin itself,

and both this tissue, and the looser parts of the true skin are often full of fat. This fat does not exist as mere free globules of fatty matter, but is contained in cells (Fig. 8, p. 833) by which it has been secreted, and these cells are usually

FIG. 4.



COW HIDE—GRAIN SURFACE, MAGNIFIED.

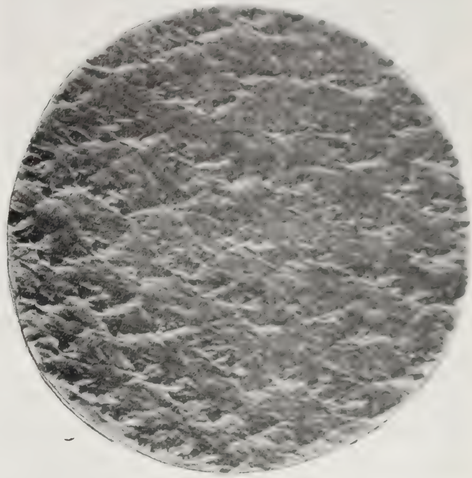
so full of oily matter that the protoplasm and nucleus of the cell are pressed closely against the cell-wall. This fact is not without its importance to the tanner, since it explains the impossibility of removing the fat till the cell-

FIG. 5.

WELSH SHEEP—GRAIN SURFACE, MAGNIFIED.

walls have been broken down by the solvent action of milk of lime, or the liquefying ferments of bacteria. The structure of the true skin may be roughly likened to that of a piece of broadcloth, which is composed of woollen yarns, each containing a large number of separate wool-fibres, these on the outer surface are more or less separated from the yarn by milling, and felted together among themselves to a close surface in which no separate threads

FIG. 6.



EAST INDIA SHEEP—GRAIN SURFACE, MAGNIFIED.

are visible. The analogy would be still closer if the cloth were sized, so as to cement the fibres together into a coherent mass.

Turning to the chemical constitution of the skin and epidermis, we find the same broad

FIG. 7.

EAST INDIA GOAT—GRAIN SURFACE, MAGNIFIED.

differences which have been marked out by their anatomical structure. The keratins, of which the cell-walls of the epidermis are formed, are closely related to coagulated albumin, of which the most familiar instance is the white of

a hard-boiled egg, and like it are insoluble even in boiling water; if, by heating at a high temperature under pressure they are at length dissolved, they form a viscid solution which does not set to a jelly on cooling. They are almost equally insoluble in acids, but are comparatively readily soluble in alkaline solutions, though there are great differences in this respect between the soft parts such as the growing layer of the epidermis, and the harder structures, such as hoofs, horns, and hair. Alkaline sulphides, such as those of sodium and calcium, have a quite peculiar effect on the keratins, dissolving and breaking up even the harder tissues with great rapidity, while their effect on the true skin is comparatively slight; and they are therefore becoming of great technical importance in freeing the skin from hair and epidermis before tanning. As regards the actual chemical constitution of keratins, or even of albumins, little is known, and it may suffice here merely to state that like most other animal products they are compounds of carbon, oxygen, hydrogen, and nitrogen, with, in addition, a trace of sulphur and of inorganic ash.

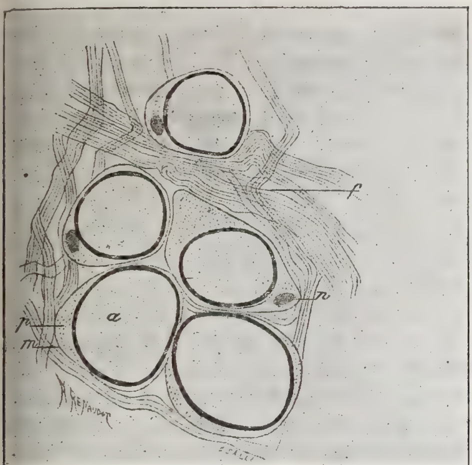
Unlike the keratins, the white fibres of the true skin, which constitute perhaps 95 per cent. of its solids, are swollen even by cold water, and readily dissolve by the aid of moderate heat, forming a solution which is merely viscid while hot, but which sets to a firm jelly on cooling. In fact the only product of the treatment of white skin-fibres with hot water is gelatin, and the true skin is one of the most important commercial sources of gelatin and glue; the other being the gelatinous tissue of bones, which only differ from skin in anatomical structure, and in being loaded with mineral matter, principally calcium phosphate. When the latter is dissolved out by treatment with dilute acid (usually hydrochloric) a semi-transparent elastic mass remains, which is dissolved on boiling with water, precisely in the same way as skin. Whether bones or skin-cuttings are employed, the commercial process for making gelatin consists firstly in a most careful purification of the material from mineral and objectionable animal matters, and then a cautious digestion to dissolve the gelatin. The clear solution is then rapidly cooled in troughs or moulds till it has set to a firm jelly, when it is cut into thin slices by a machine which forces it through a sort of grating of steel blades. The slices are laid on netting, and rapidly dried in a current of warm air, and are then ready for use. Occasionally, instead of cooling and cutting in the way I have described, the gelatine solution is concentrated by evaporation in vacuo, generally in a Yaryan apparatus, and run on to glass plates, where it stiffens, and the drying is completed on the nets. The manufacture of glue (Fig. 9, p. 833) only differs from that of gelatine in the lessened care used in purification, and in the thicker sheets in which it is dried, and in fact, very common glues are used in some branches of confectionery work. The idea that glue is made from horns and hoofs is a popular error, since it has just been stated that these tissues are only soluble in water by the aid of extreme heat and long digestion, and that the solution, when obtained, has no power of setting to a jelly on cooling. It has probably arisen from the common use of the porous bone which fills the interior of cows' horns, and which has of course a similar shape. Gelatine is most readily dissolved by soaking for a short time in cold water, which it absorbs, and swells up into a jelly, which on heating to 35° or 40° C. at once melts into solution. For culinary purposes it it is best to throw away the cold water in which it has been soaked, especially if the gelatine is not of first-rate quality; as practically none of the gelatine is dissolved, while many of the impurities are soluble and so got rid of. The swollen gelatine may then be melted simply by pouring hot water upon it. Where good setting power is desired, it is necessary to avoid the use of much heat, or of frequent meltings, as gelatine easily passes into soluble modifications which have no setting power.

If dried skin is soaked in cold water, it swells much in the same way as gelatine, but it is not nearly so easily liquified by the application of heat, but must be cooked for a considerable time before it passes into solution. The white fibre is therefore not absolutely identical with gelatine, but probably differs slightly in its degree of hydration, as ordinary gelatine strongly dried at a high temperature becomes much less soluble in water.

If the white fibres of skin, or ordinary dried gelatine be treated with very dilute acid or alkaline solutions, they absorb a much larger volume of the solution than they would do of pure water, but very little of the fibre or gelatine is dissolved. With somewhat stronger solutions the fibre is less swollen, but more dissolved, and moderately strong acids and alkalis dissolve it freely, apparently without decomposition. Very strong acids and alkalis on the other hand break it down into simpler products, first into peptones, and later into

amido-acids, ammonia, and probably other products. These points are of importance, both as regards the theory and practice of leather manufacture, and it will be necessary to recur to them at a later stage.

FIG. 8.



FAT CELLS.

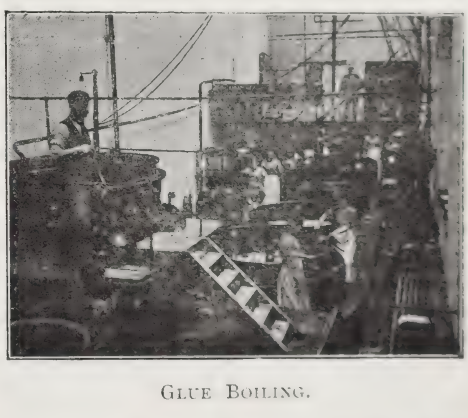
a, fat globule; m, cell wall; p, protoplasm; n, nucleus, f, fibre bundle of *corium*.

We are now in a position to consider the treatment of the raw hide or skin preparatory to tanning, and though the details of the process will differ with the kind of skin, and the purpose for which the leather is intended, the principles are so far identical in all classes of leather, that it will be convenient, at least at first, to take a broad general view, rather than to deal in detail with individual cases. In primitive times, we may presume that skins were first dressed with their hair or fur, but this is now exceptional, and when it is done, belongs rather to the province of the furrier than the leather manufacturer. We have, therefore, before tanning, to cleanse, and in some cases to soak and soften the skins, and to treat them in such a way as to dissolve the epidermis and loosen the hair, and then both hair and epidermis must be mechanically removed, since neither of them are desired in the finished leather. It is also frequently necessary to adopt special means to remove the lime and other chemicals which have been used in these preliminary operations, but which would prove injurious during tanning, and to bring the fibrous tissue of the hide itself into a suitable condition to produce the kind of leather required.

Where the skins or hides have come direct from the butcher, the first step is generally to cleanse them from blood and dirt by washing in fresh cold water, which is best accomplished by soaking for a few hours in a pit or pool, and then washing for a short time in a "washwheel," which is a sort of perforated rotating drum, into which a stream of water is introduced by a pipe passing through the axle.

Raw material which has been preserved by salting or drying demands different, and more radical treatment. That which has been merely salted is the least difficult, and even this needs much more thorough soaking and washing than the fresh goods, and several changes of water. It is not that very long is required to remove the soluble salt, which dissolves at once in the water, and rapidly diffuses out of the skin if the surrounding water is frequently changed; but that the fibrous structure of the skin has been very thoroughly dehydrated by the action of the salt, and only takes up water with considerable difficulty, and not only time, but the complete removal of the salt is required before this swelling can properly take place. For ox and cow hides, three or four days' soaking in as many changes of water is needed, and this should be supplemented by 10 or 20 minutes in the washwheel. Dried goods, such as the dried "flint" hides of Texas and South and Central

FIG. 9.



GLUE BOILING.

America, or the kips of India are much more difficult to deal with, and the more so, the greater the heat to which they have been exposed in drying. It is well known that highly dried gelatine takes up water again with great difficulty, and in some experiments made by Director Eitner, the head of the Vienna Imperial

Research Institute for Leather Industries, upon calfskin, it was found that while skin dried at low temperatures softened rapidly and completely in water, samples which had been exposed to a temperature of 60° C. could not be softened sufficiently to tan even with the aid of vigorous mechanical kneading. In former times it was customary to soften dried goods of the heavier sort in soak-pits in which the water was never changed, as the putrefactive bacteria and their products have a powerful solvent influence on hide, and greatly facilitate the softening, but at the cost of a very serious loss of valuable hide substance. This method has been almost abandoned in England owing not only to its wastefulness, but to the nuisance involved; but in India the native tanners still live round ponds into which all their refuse is run, and in which they soften their hides. Twenty-four hours of such treatment at Indian temperatures is said to make the most refractory hide "as soft as a rag." The method now adopted in England for this class of goods is to place each pack or parcel in a fresh water, which is not changed till the goods are softened. This for dried kips cured with the salt earth mentioned in an earlier part of the lecture requires about a week, while so-called "arsenic-cured," which are mostly merely dried, take considerably longer. Of course, in this length of time in warm weather the soak-water becomes distinctly putrid, and the process may be considerably improved both in the interests of the tanner and the public. More frequent change of water is, however, of doubtful advantage, since putrefaction once started in the hides it will hardly be checked by mere change of water, because abundance of bacteria will remain in the skin itself; and, apart from the cost, a large volume of water slightly charged with putrefying products may be a greater nuisance and more difficult to deal with than a smaller volume containing the same amount of products, and the cost of the water must also in many cases be taken into account. Recourse must, therefore, be had either to chemicals to quicken the softening, or to antiseptics to prevent the putrefaction, or to both. For the first of these purposes, caustic soda, used at the rate of about 1 lb. per 100 gallons of water, is probably the most effective, not only producing a much more rapid and effective softening than water alone, but, as has been shown by Eitner, actually dissolving less hide substance in the time required, and so yielding a better leather, and a greater gain to the tanner. Sulphide of sodium may be used for the same purpose, but is not quite so effective. Borax has also been used, serving at the same time as an antiseptic, but since less than a 1 per cent. solution has little effect, it is probably too costly. Another promising method is the use of a very weak solution of sulphurous acid, which, when made on the spot, is cheap enough, and is at the same time a powerful disinfectant as regards putrefaction bacteria. The thickest hides, if soaked for 42 hours in a sulphurous acid solution maintained at a strength of 1 part per 1,000, and then for 24 hours in pure water, will be fully swollen without any mechanical assistance. Such hides will, however, lime very quickly, probably owing to their sterilised condition, but there is no difficulty in unhairing them by the use of a little sulphide of sodium. The use of carbolic acid and other disinfectants of the aromatic class is not very satisfactory, especially in alkaline solutions, as they are much less effective when combined with alkalis. In any case they would probably prevent the satisfactory treatment of the sewage by bacteriological filters, which seems much the most promising means of abating the nuisance of tanners' effluents.

Where the soaking is done in water only, it is usual to assist the softening by mechanical means. In this country a fulling mill or "fuller stocks" is generally used, in which two heavy hammers are alternately raised by cams, and allowed to fall on the wet hides; while in America, a modified form known as a "hide-mill" is preferred, in which the hammers are moved in pendulum fashion by cranks. Considerable care has to be taken that the hides are not submitted to these machines till they are soft enough not to be injured by the violent bending, and many tanners are now satisfied with "drumming" in a machine like a large churn, or in the washwheel already described; while where caustic soda or sulphurous acid is used for softening, no mechanical treatment at all is necessary, and this is a distinct gain not only in saving of labour, but in avoiding loss of weight in the hide, from which a good deal of partially dissolved hide substance may be worked out. Where goods are stocked, the process generally takes place after they have been soaked a few days, and they are then returned to the soak-pit until fully soft. Some sole-leather tanners now omit the stocking during soaking, and instead, drum the goods after they are partially swollen in the limes.

The lighter skins, such as calf and goat, are rarely softened by stocking, but are worked

over with a blunt unhairing knife on the flesh side, and before stocks were introduced, the same method was made to suffice for the heavier classes also.

Miscellaneous.

*CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF WATER AND SEWAGE.**

It is desirable that results of analysis should be expressed in parts per 100,000, except in the case of dissolved gases, when these should be stated as cubic centimetres of gas at 0° C. and 760 mm. in one litre of water. This method of recording results is in accordance with that suggested by the Committee appointed in 1887 to confer with the Committee of the American Association for the Advancement of Science, with a view to forming a uniform system of recording the results of water analysis.† The Committee suggest that in the case of all nitrogen compounds the results be expressed as parts of nitrogen over 100,000, including the ammonia expelled on boiling with alkaline permanganate, which should be termed albuminoid nitrogen. The nitrogen will, therefore, be returned as:—(1) Ammoniacal nitrogen from free and saline ammonia; (2) nitrous nitrogen from nitrites; (3) nitric nitrogen from nitrates; (4) organic nitrogen (either by Kjeldal or by combustion, but the process used should be stated); (5) albuminoid nitrogen. The total nitrogen of all kinds will be the sum of the first four determinations. The Committee are of opinion that the per-centage of nitrogen oxidised—that is, the ratio of 2 and 3 to 1 and 4—gives sometimes a useful measure of the stage of purification of a particular sample. The purification effected by a process will be measured by the amount of oxidised nitrogen as compared with the total amount of nitrogen existing in the crude sewage. In raw sewage and in effluents containing suspended matter it is also desirable to determine how much of the organic nitrogen is present in the suspended matter. In sampling, the Committee suggest that the bottles should be filled nearly completely with the liquid, only a small air bubble being allowed to remain in the neck of the bottle. The time at which a sample is drawn, as well as the time at which its analysis is begun, should be noted. An effluent should be drawn to correspond as nearly as possible with the original sewage, and both it and the sewage should be taken in quantities proportional to the rate of flow when that varies (*e.g.*, in the emptying of a filter-bed). In order to avoid the multiplication of analyses, the attendant at a sewage works (or any other person who draws the samples) might be provided with sets of 12 or 24 stoppered ¼ Winchester bottles, one of which should be filled every hour or every two hours, and on the label of each bottle the rate of flow at the time should be written. When the bottles reach the laboratory quantities should be taken from each, proportional to these rates of flow, and mixed together, by which means a fair average sample for the 24 hours would be obtained. The Committee at present are unable to suggest a method of reporting bacterial results, including incubator tests, which is likely to be acceptable to all workers.

Dr. Samuel Rideal, the secretary, in sending this report to *The Times*, writes:—"The Committee are anxious that all official reports in this country shall be reported in a similar manner, as it will then enable such reports to be compared with one another without calculation. It will be noticed that the report urges the adoption of the system of recording the results adopted originally by the Rivers Pollution Commission, and which was confirmed by the committee of the American Association for the Advancement of Science in 1887, and I believe it is no breach of confidence for me to add that the Royal Commission at present sitting will also conform to these suggestions. A further advantage of the 'parts per 100,000' over 'grains per gallon' is that continental results are always recorded in this manner. The Committee hope next year to supplement this report by further recommendations to cover those other points not embodied in the present report, and, as secretary of the Committee, I shall be glad to receive the views of other workers to lay before the Committee."

* Interim Report of a Committee appointed by the British Association to establish a uniform system of recording the results of the chemical and bacteriological examination of water and sewage, consisting of Professor W. Ramsay (Chairman), Dr. Rideal (Secretary), Sir William Crookes, Professor Frank Clowes, Professor Percy F. Frankland, and Professor R. Boyce.

† British Association Report, 1887.

JAPANESE AND CHINESE PAPER.

The results of the inquiries of the commission of industrial experts, which was appointed by the German Government to visit and report upon the markets of East Asia, show, according to a German trade review, that the various markets present excellent prospects for the paper trade, and the paper industry generally. The Corean hand-made papers, thus far very little known in foreign countries, are of much interest. They are of yellowish colour, silk-like gloss, and extraordinary strength. In purity they are behind the better grades of Chinese papers. These papers are made in sheets about 29½ by 51 inches. Oiled papers of this kind are used in place of window glass, and very impure but extremely strong board is also made of the same raw material, as well as blotting and wrapping papers. The Japanese hand-made papers are divided into two classes. The so-called "hansi" (half paper) is loaded with about 20 per cent. of rice starch; the "minogami" consists entirely of fibre. The Hanshi papers are the stronger and coarser, and are made in

smaller sizes (about $9\frac{3}{4}$ by 13 inches), while the Minogami papers are thinner and better and of larger (11 by 16 inches). A quire of paper is called "jo" in Japanese, and has from 20 to 48 sheets; a ream is called "shime," and has from 480 to 2,400 sheets. The prices of hand-made paper have recently risen about 15 per cent., because the growers of bast demand and obtain higher prices for their product. Printing paper is used in Japan not only for printing purposes, but also for writing. The most popular sizes of printing paper are 25 by 27 inches and 31 by 43 inches flat. The consumption of paper has increased extraordinarily in Japan, and, although the home production is large, there is a good market for imported paper. Rice straw is an important factor in the manufacture of Japanese machine-made paper; only when there is a poor rice crop is wood fibre imported to any appreciable extent. Several Japanese paper mills, as well as the Fuji paper mill (the largest in Japan), produce their own wood pulp and wood fibre; the Ixono mill is said to be the only fibre mill which sells its products. Wood fibre is imported for the most part from Sweden, and fetches, according to quality, from £16 to £24 per ton. In Skiroishi and in Atami, families make a paper textile in which the warp threads consists of silk or cotton yarn, while the woof thread are twisted from narrow strips of hand-made paper. How much the production of hand-made paper increases, is demonstrated by the fact that in 1887 the total value of the production amounted to £940,000, while in 1895 it had risen to £1,820,000. The production of machine-made paper in Japan was in 1896 approximately as follows:—Fuji, 12,000,000 lbs.; Oji, 12,000,000; Kobe, 7,000,000; Senji, 6,000,000; Yakaichi, 3,000,000; Abe, 2,000,000; Yukosha, 800,000; Shimozato, 800,000; Ixono, 200,000; or a total of 43,800,000 lbs. The Muramatsu paper mills, near Shizuoka, produce excellent hand-made paper, and especially noteworthy are the napkin tissue papers, unrivalled in silky gloss and beauty, which are also painted or printed with pictures, as well as the unsurpassed Japanese crape tissue paper. Among the most curious things to be seen in Japan, are the jackets and trousers of strong hand-made paper with which the Japanese soldiers were supplied during the war between Japan and China. The seams and button holes were sewn with cotton thread. Chinese hand-made papers are made mostly of rice straw and are coloured or stained on one side by hand, for instance, crimson for visiting cards (which are thin large octavo sheets), pale red for bills, yellow sprinkled with gold or green for wrapping goods, orange for wedding finery, &c. Large quantities are consumed in the principal place of its manufacture for decorating various places of worship which are visited by Chinese from all over the country, and considerable quantities are also sent to the adjoining provinces. There is no doubt that cheap imported machine-made printing papers, stained or unstained, could successfully compete with these home-made and hand-made papers, and the East Asiatic countries would certainly appear to present an attractive and lucrative field for the European exporter of paper.

MINERAL PRODUCTION OF CHILE.

The province of Autofogasta is composed of the three departments of Tocopilla, Autofogasta, and Taltal, and each of these has its port of the same name, from which almost all the products are shipped, the other ports being minor ones. The department of Autofogasta, which is the principal one, is wonderfully rich in gold, silver, copper, salt, and anhydrite, also in lead. The production of Bolivia is nearly all exported through the port of Autofogasta, as the Autofogasta and Bolivia Railway is the only one that extends into the heart of that country, having a length of some 600 miles. Silver, copper, antimony, bismuth, tin, mercury, and sulphur are received from Bolivia. The gold mines of Autofogasta exist in three districts—San Cristobal, Santa Maria, and at the mouth of the River Loa. The gold is found in well-defined fissures, quartz lodes in quartz trachyte, and, with the exception of one mine—the Bolaco in San Cristobal—very little work has been done, chiefly owing to the lack of water which has to be taken in carts 36 miles. The United States Consul at Autofogasta says that the production of San Cristobal has averaged, for the last two years, 200 kilogrammes (440 lbs.) of fine gold annually. The per-centage has averaged 10 ozs. to the ton. The production from Santa Maria and the Loa is small. There are several silver districts in the department of Autofogasta, the most important being Caracoles, Sierra Gorda, El Inca, Paine, Laukir, Atahualpa, Aralar, Sierra de Plomo, Piquios, and Cerro de Pascua. These are distributed all over the department, and, with the exception of Sierra Gorda, the cost of transport by carts to the different stations on the railway is very heavy. The production of silver, which reached 250,000 kilogrammes (550,000 lbs.) fine in 1873, from Caracoles alone, has been reduced in subsequent years to 25,000 kilogrammes (55,000 lbs.) in the whole department. The first three districts named are the only ones at work at present. The ores are chiefly chlorides or limestone. The production of copper is gradually increasing, owing to the higher prices quoted for bar. The chief districts are Chuquicamata, Sierra Gorda, Lomas Bayas, El Desesperado, Naguayan, El Cobre, and Blanco Eucalada. The ores are chiefly green carbonates, oxychlorides (atacamite), and silicates, there being little sulphuret. None of the mines have any depth. The products of most of them suffer from the high railway rates. The production can now be estimated at 12,000 tons annually of 15 per cent. copper, or 1,800 tons fine. It is expected that this will soon be doubled. Half is shipped direct, and half used for making copper matte with a per-centage of silver, by

mixing with silver ores. There are extensive nitrate of soda fields in the department, which have been worked since the year 1870. The first discovered, at Salar, six miles in the interior of Autofogasta, have been worked out. Others found further in, and belonging to the same company, employ from 800 to 1,000 men, and produce from 30,000 to 35,000 tons a year. There are other fields in Aguas Blancas, 60 miles south-east of the port of Autofogasta, where work is to be resumed shortly. These are of vast importance, and as soon as a railway is constructed the production is expected to increase very considerably. There are extensive fields of borate of lime about 160 miles from the coast, at Ascotan, Carcote, Ollagüe, Tilopozo, and Carvagal. The only ores that can be worked at present are those of Ascotan and Carcote owing to poor railway facilities. The production is about 7,000 tons a year. There are some large deposits of sulphate of iron near Sierra Gorda which have been worked on a small scale for treating copper ores. An entire hill of very pure salt, some 20 miles in length, exists at about 150 miles from the coast. The railway is too far removed to make it available for commerce. Small deposits of anhydrite are found in different parts near Caracoles. There are some good lead mines with a small per-centage of silver in Sierra del Plomo, Cerro del Arbol, Sierra Gorda, and other districts, but they are not worked at present owing to defective means of communication. The department of Tocopilla produces gold, very little silver, copper, nitrate of soda, and borate of lime. The amount of gold won does not amount to much and is all sold in Autofagasta. As regards copper, near the port of Tocopilla there are several mines which yield sulphurets and which have been worked to a depth of 200 fathoms. In Cobija and other ports south of Tocopilla there are also very rich mines. The present production of the whole department is about 9,000 tons a year of 15 per cent. ore. All this is sold to the Lotta Company, in the south of Chile. The fields of nitrate in Toco, 50 miles inland, are extensive. They belong to different owners, and produce 100,000 tons a year. The department of Taltal produces gold, silver, nitrate of soda, and copper, all in large quantities. The famous gold mines of Guanaco produced, ten or fifteen years ago, enough to keep four large establishments going. Now the production has decreased, owing to the small amount of work carried on. It is calculated that about half a ton of pure gold is still produced. The ores are all milled in the port of Taltal. There are some very rich silver districts, amongst which may be mentioned Cachinol (including the famous Arturo Prat mine), Sierra Esmeralda, Griton, Cifunchos, and Argolla. With the exception of the first-named, there is very little work done; still, the production is not less than 25 tons of bar silver. The nitrate fields are very extensive, and have, like the others in the province, their railway. The yearly production is about 90,000 tons. There are several copper mines, the production of which amounts to about 4,000 tons a year of 18 per cent. ore.

INFLUENCE OF BACTERIA ON THE DECAY OF CEMENT.

The Analyist quotes from a paper by A. Stutzer and R. Hartleb on this subject in the *Zeitschrift angew. Chem.* In 1896, Stutzer observed that the cement mortar which had been in use for eight or nine years as lining to a water-supply reservoir was converted into a brownish mud, containing less lime and more iron oxide, &c., than the original cement. This disintegration he ascribed, and still believes to be primarily due, to the solvent action of the carbon dioxide in the water, which dissolved the lime of the cement in the form of bicarbonate. But on extracting further samples of the mud from the same reservoir lately with sterilised water, the present authors found that it was highly charged with nitrifying organisms; so much so, that when introduced into a 0·1 per cent. solution of ammonium sulphate, the ammonia reaction practically disappeared in fourteen days, and nitrite reactions were given powerfully. A similar experiment with asparagine only gave a nitrite reaction after six weeks, but here it was necessary for ammonia first to be formed before nitrification could set in. A further test with a 0·1 per cent. solution of sodium nitrite showed that nitrites were formed but slowly. It would appear possible, therefore, in the case of waters containing any appreciable proportion of oxidisible nitrogenous matter, that this production of nitrous acid by the agency of micro-organisms may play some part in the destruction of cement. The parallel action that is noticed in sea-water, unless the cement is fortified by the addition of extra active silica, is due rather to the soluble sulphates than to carbon dioxide, which is not present in such large quantities as in fresh water; it has not been feasible to determine whether bacteria assist in this disintegration likewise.

With reference to this matter, G. Barth, in the same journal, quotes another instance of cement decomposition occurring in three years where the water contained no unusual amount of carbon dioxide, and he seems to consider the previous explanation plausible.

GLASS AND PORCELAIN INDUSTRIES OF BOHEMIA.

The northern portion of Bohemia, though without a large city, supports a population of about 375 to the square mile, making it the most densely populated part of Austria-Hungary. It is rich in mineral wealth, having the iron of the Erzgebirge and the rich coalfields of the Eger River Valley in close proximity, and has the best material for the manufacture of porcelain, pottery, terra-cotta ware, and

the world-renowned Bohemian glass-ware. The Eger river, one of the tributaries of the Elbe, waters the western, and the Elbe, the northern part of this section. The coal beds of the Eger valley are among the richest of the Continent, and find their shipping point mostly at Aussig on the Elbe. Rich kaolin and terra-cotta beds yield the material for the porcelain and pottery manufactured and hand-painted in many of the villages. For this latter, which is largely a home industry at very low wages, some of the colours (as ultramarine, chrome green, and alizarin) are also of home manufacture. The United States Consular-Agent at Haida says that this porcelain and pottery industry is carried on in the villages and towns all the way from the environs of Karlsbad to to Tetschen-Badenbach. Tetschen has also a large factory of buttons, made of "vegetable ivory." In the northern quarter of the region described, all the materials exist for the production of the clearest crystal glass. The people have had experience of over 200 years in converting the crude material into the best glass, and shaping it into the choicest utensils and ornaments, by cutting, polishing, engraving, painting, and gilding. All this has given Bohemian glass a world-wide renown. The refining is largely a home industry at very low wages; the wives, daughters, and sisters of the male workers. Some of them, real artists, carry the ware in large baskets on their backs up and down the mountains between the factories and their own homes. The wages range; for women's work, consisting mostly of washing, packing, and carrying the glass, from 5s. 2d. to 8s. 4d. a week. Men receive the following:—Glass cutters, 10s. 4d. to 14s. 6d., engravers, 16s. 8d., to 25s., painters and gilders, generally including those who are employed in burning and burnishing, 21s. to 33s. 4d., the best painters, capable of doing good portrait work, may earn 42s. to 50s. a weeh. All this labour is counted at eleven working hours a day, and workers supply their own food, and often the fuel for burning in the paint. Haida, forming with Arnsdorf one town of 6,000 inhabitants, is the centre of this industry, and it is estimated that within a six-mile radius of Haida, 10,000 people are engaged in this industry of glass refining.

LEATHER INDUSTRY IN GERMANY.

According to Consul-General Sir Charles Oppenheimer, a result of the study by German experts of American progress is the establishment of a German leather industry. Germans claim to have themselves invented the manufacture of leather with the use of chrome salts, and Dr. Heinzerling, of Frankfort-on-the-Main, is named as the inventor of this process, which, in the year 1884, was finished by Schulz in America for technical use. This leather appeared first in the latter eighties on the American market. It is said especially to possess greater resisting power against dampness than ordinary chevreau leather. Six to seven years ago German factories commenced to manufacture chevreau from chrome. A firm bought several patents, and sent experts to America to study the process on the spot. This factory is furnished with new American tannery machinery, which is capable of turning out daily 500 dozen goat-skins, and they contemplate raising the output to 1,000 dozen per day. The factory has succeeded in working off hides from various sources, with like success. Another German firm is said to have been successful in manufacturing calf, cow, and strap leather with chrome salts, according to a new process invented by Dr. Heinzerling. This success has caused great rejoicing in Germany, and German papers conclude from this that the technical and commercial methods of the Americans ought to be studied by proper skilled experts in order to be able to beat the work of the Americans. As to the branches of trade which, in this connection, are next to be taken in hand, are mentioned the shoe, bicycle, and iron industries.

General Notes.

CONGRESS OF HYGIENE AND DEMOGRAPHY.—The following letter has been received from the Science and Art Department:—

"27th September, 1899.

"SIR,—I am directed to state that the Department of Science and Art has received, through the Foreign Office, a copy of a note from the French Minister at this Court, stating that the Tenth International Congress of Hygiene and Demography will be held in Paris from the 9th to the 17th of August, 1900, and that the French Government are desirous that Her Majesty's Government should be represented by one or more delegates. It is pointed out that the President of the Congress, Dr. Brouardel, Dean of the Faculty of Medicine of Paris, would be glad if a special committee were formed in England, with which the Organising Committee could communicate respecting the participation of other countries, the preparation of the prospectus, and kindred questions. I am to request that you will be so good as to cause this information to be published in the *Journal of the Society of Arts*.

"I am, &c.,

"W. DE W. ABNEY."

LUXEMBURG KID GLOVE MANUFACTURE.—In the article on this subject, published on p. 806 of the *Journal* for 15th September, it is stated that Luxemburg exports about 50,000 pairs of gloves yearly; but M. Reinhard calls attention to the fact that the figure is 50,000 *dozen* pairs, a number which he alone has exported in a single year.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1900.

The dates fixed for the Examinations in 1900 are Monday, March 26th; Tuesday, 27th; Wednesday, 28th; and Thursday, 29th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix, containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, W.C.

Proceedings of the Society.

CANTOR LECTURES.

THE MANUFACTURE OF LEATHER.

By Prof. Henry R. Procter.

LECTURE II.—Delivered April 24, 1899.

In the last lecture we left the hide or skin softened, and thoroughly washed from salt and dirt. It still requires both chemical and mechanical treatment before it is ready for actual conversion into leather. The hair must be loosened, so that it can be removed. The inner or flesh side must be freed from loose underlying tissue and fragments of flesh left on by the butcher, and the hide cleansed as far as possible from fat and the remains of epidermis tissues such as hair roots and glands. It is also necessary, either at this stage, or at the very beginning of tanning, that the gelatinous fibres of the skin should be swollen by some agent, either acid or alkaline, which has the power of splitting the fibre-bundles into their finer fibrils, so as to increase their bulk, and the surface they present to the action of the tanning substance. If, as is most usually the case, lime has been used in this preliminary treatment, it is necessary to secure its removal, especially if vegetable tans are to be used, and, where soft and flexible leathers are required, to bring the fibres back from their swollen state to a soft and flaccid one, since if tanned in a swollen condition the leather would be hard and in extreme cases even brittle.

The agents which are practically used to loosen the hair are putrefactive fermentation, lime and other alkalies, and alkaline sulphides. The putrefactive method may fitly be first considered as no doubt it was the first in historical sequence. If hides or skins are allowed to remain for a few days in warm weather in a damp condition without the use of antiseptics, putrefaction sets in, beginning perhaps first in the lymph and liquid contents of the skin, but spreading rapidly to the soft and growing layer of the epidermis, which it liquifies and destroys. As this layer surrounds the roots of the hair, the latter is loosened, or, as the tanners say, "slips." To the primeval huntsman this accident must frequently have occurred, and where he has set his soul on a fur jacket must have been very annoying, but it probably gave the idea of the earliest method of removing the hair where its removal was needed. In much later times the common method was to lay the hides in pile or to fold them up in a warm and damp place, sometimes after a previous washing and light salting to lessen the danger of putrefaction spreading to the true skin itself until the hair was loosened. The method is still largely in use for special purposes, but in a somewhat modified form. Instead of laying the hides together, where they cannot be examined and where the action is apt to be irregular from uneven heating of the skin, or from other causes, they are now hung up in a room which can be moistened by water sprinklers and warmed by steam, and which is generally so arranged as to be protected from sudden changes of temperature and with but little ventilation. The process is called "staling" or "sweating," and one of its most important applications is to the unwooling of sheepkins; as in this case the value of the wool is generally much greater than that of the pelt, and wool is injured by lime and most of the other chemical means of loosening the hair. After the previously washed skins have been hung in this way for about a week, the wool is so thoroughly loosened that the "woolpuller" spreading the skin on a sloping "beam" in front of him can push it off with his hands, separating into different baskets the various qualities which are found on different parts of the animal.

Another case in which a similar putrefactive method is frequently employed is in the manufacture of sole-leather, and especially that made in the United States from dry hides. In this case the aim is to avoid solution or washing out of any of the constituents of the skin, and so to obtain a heavier yield of a firmer and more solid leather. When the process is properly conducted the effect is almost entirely confined to the soft growing cells of the epidermis, and putrid ferments have no effect in swelling or splitting up the fibre-bundles. It is, therefore, necessary in the case of sheepskins to lime them, much like skins from which the hair has not been removed, so as to fit them for tanning, while in the case of heavy hides for sole-leather the necessary swelling is effected by the use of acid at the beginning of the tanning process, before which they sometimes also receive a light liming. It is probable that the failure of English attempts to produce a satisfactory sole-leather by the sweating process has often been due to ignorance of this essential condition to success.

There is but little to be said in scientific explanation of these methods. The bacteriological process is of course a very mixed one, and no special care is or perhaps can be taken to secure the right organisms, beyond choosing conditions of temperature and moisture which favour a rapid and satisfactory action. It is stated, however, by von Schroeder that the bacteria which are most active in loosening the hair have little effect on the skin itself. There is no doubt that a considerable part of the solvent effect on the epidermis is not due alone to the direct action of the bacteria, nor even of the solvent ferments which they produce, but to the ammonia which is freely given off during the process, and acts like other alkalies in loosening and dissolving the epidermis. A piece of fresh skin hung in a beaker over a little liquid ammonia has the hair loosened as much in a few hours as it would be in some days of putrefaction. The greatest danger of the method is the spreading of the putrefaction from the epidermis layer into the surface of the true skin, and it rarely happens that some damage is not done to the delicate hyaline layer which should form a sort of glaze to the finished leather. Such damage shows itself by a whitish and dull appearance of the surface, and in coloured leathers by irregular dyeing.

Liming is a far more important means of loosening the hair than putrefaction and one in far more general use. Lime in common with other alkalies has not only a solvent effect on the epidermis, but swells the fibres of the true skin, and splits them up into their constituent fibrils, and as both these effects are essential to the production of a good leather, we have in lime an agent admirably adapted for our purpose. Not the least of its virtues is its limited solubility in water, not much exceeding 1¼ parts per 1,000, which renders its action mild and gradual, and the employment of an excess innocuous, since only the dissolved portion acts on the skin. In practice a milk of lime is always used, so that as the lime is consumed by the skin the solid portion passes into the solution and keeps it of uniform strength. If caustic soda or potash were substituted for lime, the very weak solution which alone could be safely used without skilled chemical control would become very rapidly exhausted, and its strength would have to be constantly renewed by additions, which in milk of lime take place automatically. In practice the hides or skins are generally drawn into a pit filled with well mixed milk of lime, and allowed to sink in it in a position as flat and straight as possible, and so that a small quantity of the undissolved lime settles between them. After lying, say 24 hours, the hides are drawn out with hooks (tongs are frequently used for skins), the lime is well stirred or plunged up, and the goods are returned to it, and this process is repeated daily till the hair or wool is sufficiently loosened, which usually requires from a week to ten days. The more frequently the goods are handled and fresh lime and liquor brought into contact with them, the more rapidly will they unhair and the less excess of lime will be required. Sole-leather tanners, who are often negligent in this respect, frequently use as much as 10 or 12 per cent. on the raw weight of the skin, but it is probable that not more than 2 or 3 per cent. is actually consumed. The lime pit is generally used repeatedly on successive parcels of hides or skins, and in making a new lime liquor, a considerable excess of lime must be used, about double of what is needed to strengthen it for a new "pack." Von Schroeder found that 6 grammes of CaO per litre was a suitable strength, but in practice much more is generally added. The chemistry of the liming process is by no means so simple as might at first sight appear. Its effects are not due to the chemical action of the lime alone, but also to that of the enzyme products of bacteria, without which so weak an alkaline solution would have little solvent action on the

epidermis structures. Sound sterilised hides in a sterilised lime will not unhair in any reasonable time by the action of the lime alone, but if previous to liming they have undergone slight putrefaction, or been submitted to the action of the ferments of a putrid soak, or if a small quantity of such ferments is introduced into the lime liquor itself, unhairing will take place in a normal way.

The effect of this combined action of bacteria and lime is to break down the epidermis matter of the skin, first into soluble forms identical with peptones or nearly so, and then into simpler and simpler products as time goes on, till we arrive at amines and amido-acids, often of the fatty series, and finally at ammonia, carbonic acid, and water. An old lime contains, in addition to the full quantity of caustic lime which it will dissolve, a large amount of dissolved lime which is no longer caustic, but combined with weak organic acids, together with ammonia, peptonised hide substance, and a large number of living bacteria and their products, some of which are the solvent ferments or enzymes of which I have spoken. It therefore happens that, contrary to the usual belief of tanners, an old lime is much stronger than a fresh one in its solvent effect on hide, although it swells it less, since the enzymes have an effect like that of a puer liquor, directly opposed to swelling; and ammonia swells much less than lime, though its solvent effect is greater. The effect of such old limes is, therefore, to dissolve and loosen the fibrous tissue of the skin, giving poor weights and spongy leather, and where the limes are very stale there is a great danger of injury to the grain by the direct action of bacteria. Absolutely new limes, on the other hand, swell the fibre well with very little loss of hide substance, but if the hides have not undergone any previous putrefactive action, they loosen the hair very slowly.

Between these two extremes the tanner has it in his hands to produce considerable variation in the effect of liming. Thus for sole-leather, where solidity and thickness are points of prime importance, only new or nearly new limes should be employed, since the object is to swell with as little solution and loss of hide substance as possible; while for dressing leathers which require softness, somewhat older limes may be usefully employed, though in no case should this be carried so far as to endanger active putrefaction and damage to the grain. It is generally advantageous to work the limes in series, beginning in an old lime when the solvent action is most useful and least injurious, and finishing in a fresh one which plumps better and is less dangerous.

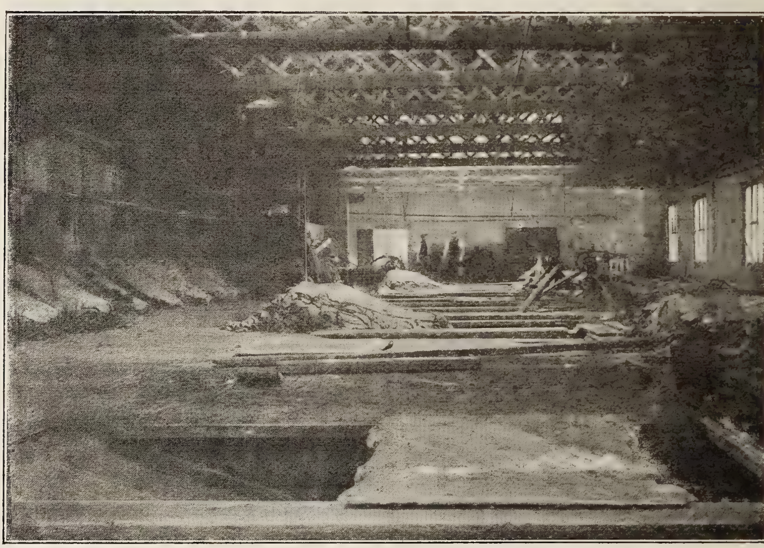
The temperature of the lime is a matter of some importance. Contrary to the usual rule the solubility of lime diminishes with increased temperature, but at the same time its solvent action increases still more rapidly, and its power of swelling diminishes, so that a warm lime unhairs much more quickly than a cold one, but with less swelling and more solvent action on the skin, so that loose and light-weighing leather generally results. In the case of sole-leather especially the use of warm limes is a fatal mistake, but on the other hand, at very low temperatures the action is almost arrested, and to obtain uniform results it is best to maintain them at a temperature of about 60° Fahr. There is, however, one way in which heat may be satisfactorily employed to assist liming, which is often called the "Buffalo method," because of the place where it originated. If hides after a comparatively short liming are placed for some hours in warm water, the removal of the hair is much facilitated, and less hide-substance is dissolved than in the longer liming which is otherwise necessary. In the States the method is often employed for sole-leather, the liming being in extreme cases reduced to 10 hours and the hides being left in water heated to 100-110° Fahr. overnight. But little lime is used, but it is frequently strengthened with a small quantity of sodium sulphide, say 4 oz. per hide. In such extreme cases the hide contains but little lime, and its fibre is scarcely swollen, so that recourse must be had to swelling with acid before tanning, as in the case of sweated hides. It is however obvious that any result between this and that of ordinary liming may be obtained by the appropriate use of warm water.

An indirect method of liming has been very recently patented by Messrs. Pullman, of Godalming, which possesses much scientific interest, and promises to be of considerable commercial importance. From the difficult solubility of lime, and the consequently weak solutions which must be employed, the ordinary process of liming is a slow one. Caustic soda, on the other hand, can be used in much stronger solution than caustic lime without injury to the hide, and from its great powers of diffusion penetrates very rapidly. By treating a hide which has been saturated with caustic soda with a neutral soluble salt of calcium, a double decomposition takes place, and caustic lime is formed actually in the

interior of the fibre of the hide. Both solutions may be used in any convenient way, as for instance, in pits or paddles, but for rapid work a drum is the most convenient, as a comparatively small volume of liquid is sufficient to treat a considerable quantity of hides. Through the kindness of Messrs. Pullman I had the opportunity lately of watching the treatment of a lot of 15 salted hides throughout the process. As my time was limited, the goods were drummed with the soda solution for only about three hours, and with the lime salt for less than an hour, at the end of which time the goods were fully plumped and ready for unhairing, though perhaps the hair was rather tight, as preferably they should have had at way. Another very important point is, that as soda soaps are soluble and easily emulsify grease, the latter is much more completely removed than by the ordinary method.

The most curious point about the invention is that if the skins are free from putrefaction and kept in a sterilised condition before treatment, no immediate loosening of the hair takes place, though they may be fully limed, and it is thus possible to properly prepare them for tanning with the hair on. A short soaking before liming in an old soak liquor, or an addition of sodium sulphide to the caustic solution, will cause the hair to loosen at once, thus proving the importance of the bacterial action in the limes to which I have already alluded.

Fig. 10.



Sole-leather Limeyard. Penketh Tanning Co., Ltd.

least an hour longer in the soda solution. Apart from this they had the appearance of being fully limed; and though I was not able to follow the tanning process further, I see no reason why they should not turn out good leather. Messrs. Pullman assure me that the method is not more costly than the ordinary one, and if it proves on further experience to turn out an equally satisfactory product, it will have the great advantages that no lime slab, and only a very moderate quantity of waste liquor is produced, that the time is very much lessened, as well as the plant required for treating a given quantity of hides, and that the amount of liming effect produced can be regulated much more accurately than in the ordinary

Of late years the alkaline sulphydrates, either alone or in conjunction with lime, have come very much into use as unhairing agents. It has long been known that these compounds had a very curious effect on the hair and harder keratin tissues, breaking them up, and dissolving them in a way very different to the caustic alkalis, which act slowly in the cold on the harder structures, though they gradually loosen and dissolve the soft and growing cells. Hair, for instance, moistened with a strong solution of calcium or sodium sulphydrate, is rapidly reduced to a pulp, its inner contents being so far liquified that under the microscope it has the appearance of strings of sausages, and in a few hours can be washed off or swept

off the skin with a broom. On the other hand, the effect of these compounds on the gelatinous fibres of the true skin is much less powerful than that of the caustic alkalies, neither dissolving nor swelling them to any great extent; so that a hide unhaired with sulphydrates is left in a much less altered condition than with lime, and with less solution of the cementing substance of the fibre bundles, so that if suitably tanned or tawed, it gives a more solid and less porous leather. The chemistry of the reaction on the hair has not yet been studied, but the sulphydrates disappear (as such) from the solution.

Red arsenic has always been objectionable, both from its expense and its poisonous character, and of recent years the restrictions on its use imposed by the German and Austrian Governments have been so severe as to render the discovery of an effective substitute of great importance. The effective agent in the mixture of realgar and lime is the calcium sulphydrate formed, and many years ago it was shown by Boettger that it could be equally well produced direct by passing hydrogen sulphide into milk of lime, but unfortunately the compound is very unstable, and its manufacture on the spot is too troublesome and costly for general adoption. Gas lime and calcium sulphide residues of the Leblanc soda process have both in their time been tried as sources of calcium sulphydrate, but with only partial success, and it was not until the introduction of crystallised sodium sulphide by a German firm of chemical manufacturers that any great progress was made. The material crystallises with nearly 70 per cent. of water (10 eq.), and is somewhat deliquescent, but keeps well. As it is not a sulphydrate but a sulphide, its solution in water may be regarded as a mixture of equivalent parts of sodium sulphydrate and sodium hydrate, and it is not improbable that it really dissociates in this way:—

$$Na_2S + OH_2 = NaOH + NaSH.$$

FIG. 11.

UNHAIRING. PENKETH TANNING CO., LTD.

The first application of this principle seems to have originated in the East, where a mixture of lime and realgar (a red sulphide of arsenic) has long been used as a somewhat dangerous means of removing superfluous hair from the face. It is very possible that its use was introduced into Spain by the Moors, to whom many of the mediæval improvements in arts and manufactures are due. The mixture is still largely used in the manufacture of glove kid, and some of the finer sorts of leather, either alone, or as an addition to the ordinary limepit, where it enables the skin to be thoroughly cleansed from the epidermis structures, without so much loosening its texture as lime alone would do.

Its action on the skin supports this view, as it swells the gelatinous fibres much more than calcium sulphydrate, as would be expected from a mixture containing caustic soda. When sodium sulphide is mixed with slaked lime, a mutual decomposition occurs—

$$2Na_2S + Ca(OH)_2 = Ca(SH)_2 + 2NaOH,$$

and calcium sulphydrate is formed, together with an equivalent quantity of sodium hydrate. The formation of caustic soda is probably the reason why the mixture has not proved an entirely satisfactory substitute for that with red arsenic, in which no caustic soda is formed, but it has come into extensive and important use in unhairing a great variety of leathers which were formerly treated with lime alone, and it is especially available for the heavier dressing leathers where toughness and solidity are important.

Sulphide of sodium and the sulphydrates may be practically employed for unhairing in several ways. With a paste of calcium sulphydrate, or a strong solution of sodium sulphide thickened with lime, skins and hides may be unhaired in a few hours, either by applying it direct to the hair side, when the hair is of course destroyed; or by painting it on the flesh, when it penetrates the skin and destroys the roots of the hair or wool. The latter method is frequently used for sheepskins, where the wool is valuable, as a substitute for "staling." For sole-leather the mixture is frequently applied direct to the hair, which is of comparatively little value, but it is difficult to ensure its penetration to the roots, and if a spot is left untouched, the hair must be shaved off. To obviate this the hides are now frequently brushed or paddled for a short time in a strong unthickened solution of sodium sulphide, and then laid in pile till the hair is destroyed, when it can be removed by drumming in the wash-wheel with water. Where these rapid methods are adopted, the fibre is practically unswollen, and before tannage the hides must be swollen with acid.

A much more common and important method of use is to add a small portion of sulphide of sodium to the limes, perhaps four ounces per hide, when the unhairing will be more rapid, and the solution of the cementing substance of the fibres less than with lime alone.

The discovery of a thoroughly satisfactory substitute for realgar is still a desideratum. Calcium sulphide is insoluble in water, and at ordinary temperatures will not take up the water necessary to convert it into a mixture of sulphydrate and hydrate. The sulphydrate is too unstable for commercial use, and its solution is not sufficiently concentrated for cheap carriage. Barium sulphide is soluble in water like the sodium compound, but is more expensive, and so far as it has been experimented with, somewhat less convenient. Some of the polysulphides of calcium are pretty soluble, and cheap, and though they have no unhairing powers alone, they apparently form calcium sulphydrate on mixture with lime. A mixture, probably of calcium sulphydrate and polysulphides, is being pretty extensively used in Austria in place of realgar, under the name of "calcin." Polysulphides seem to have great power of reducing the swollen condition of hide fibre, and hence may prove useful as "bates" or liquors for diminishing swelling. The "tank waste" or calcium sulphide residues of the Leblanc process become soluble by the action of air and carbonic acid, forming a complex mixture of polysulphides and thiosulphates, and good results in unhairing were obtained some years ago by Mr. J. Muir, of Beith, by first lightly liming, and then treating the hides with this solution, which in conjunction with the lime, rapidly loosened the hair.

So far we have confined our attention solely to the chemical treatment of the hide or skin prior to unhairing. The actual mechanical removal of the hair generally takes place on a sloping beam or iron or wood with a convex surface, over which the workman leans, and pushes the hair off with a blunt two-handled knife. Various machines have been devised to accomplish this labour, but they have not as yet come very largely into use, mainly because the hand work is rapid and not difficult, and judgment can be used in working off the hair on any spot where it is tighter than usual, while machines in many cases leave spots which have afterwards to be removed by hand on the beam. Sometimes goods are unhaired in the wash-wheel or by fulling in the "stocks."

After unhairing the skins or hides are usually "fleshed." This operation is done on the same beam on which the goods are unhaired, but a sharp two-edged knife is employed, with which adhering fat, flesh, and losse tissue left on by the butcher is removed, partly by cutting, partly by scraping. In England this is still most frequently accomplished by hand, but in America, on the cheaper classes of upper-leather, machines are almost invariably used, and the fleshing usually takes place in the hair and before liming. There are reasons why this method cannot perhaps be generally adopted in England which time will not allow

me to explain here, but I believe by suitable changes in the after treatment of the leather it could be much more often employed than it is. Even in the United States the fleshing of sole-leather is usually done by hand. The machines used mostly depend for their essential action on a cylinder with spiral blades under which the hide or skin is drawn.

Whenever the hides have been treated with lime it is necessary that this should be removed before tanning, as it forms insoluble compounds with the tannins, which oxidise and darken on exposure to the air and spoil the colour of the leather. Where soft and pliable leathers are to be manufactured it is also necessary to reduce the swollen condition of the fibre produced by lime, and in some cases also to dissolve a further portion of the cementing substance of the fibres, so as to give the leather more stretch and softness. Hitherto these results have mostly been obtained by various fermentation processes, often of a disgusting character, but there now seems a possibility of superseding them by cleaner and more reliable methods. In considering the chemistry of the subject, we must remember that, as in the case of liming, more than one effect at the same time has been attained by the older processes, and that no method will supersede the old one if it only provides for one of these effects. On the other hand, while the removal of the lime is always desired, the solution of the fibre substance is demanded in very different degrees for different classes of leather, and in many cases would be better avoided altogether. The reduction of the swelling is mainly an osmotic effect, and is by no means directly connected with the solution of the fibre, but may to a considerable extent be brought about by the mere removal of the alkaline condition caused by lime. I hope in the next lecture to consider a little more closely the chemistry and physics of these phenomena of swelling and shrinking, in connection with the theory of the tanning process, but, for the moment, it may suffice us to remember that the presence of the lime increases the capacity of the fibre to absorb water, and so causes it to swell up.

FIG. 12.

FLESHING.

We have, therefore, to consider in the first place the best means for the removal of the lime, since in many cases, this alone will suffice, as, for instance, in the production of harness leather, where a firm texture and reasonable softness are all that is required. Naturally the neutralisation of lime with an acid is the first idea which would occur to the chemist in this connection, but there are certain difficulties which must be provided for before it can be successfully carried out. Mere washing of the lime out with water is generally im-

practicable, since it is combined with the fibre, physically or chemically, in such a way that it will not diffuse into water in any reasonable length of time. If the lime can be exactly neutralised with acid, the neutral salt can be easily washed out, if it is soluble, but if the acid is employed in the least excess, it is greedily absorbed by the fibre, which again swells, and it becomes as great an evil as the lime, which it has expelled. It is, therefore, necessary to exactly adjust the quantity of acid to the lime in the skins, and rather to leave a trace of lime unremoved, than to use acid in excess. For dressing leather, the operation is best performed in a vat with a paddle to keep the skins in motion in water at a temperature of about blood heat, and sulphuric acid is as good as any other, as the calcium sulphate formed is more soluble than the lime itself. By experience the required quantity of acid may be exactly known, but if not, it is necessary to proceed tentatively, adding the acid little by little, and judging principally by the feel of the skin. Test paper in the liquid is of little service, as the acid will be completely absorbed by the skin long after all the lime is neutralised; but the skin itself may be tested by applying a solution of phenolphthalein to a cut surface, which will turn pink so long as lime is present. For sole-leather, the hides are best suspended in cold water, in which they are kept in gentle motion, and a sufficient quantity of acid is added at once to remove the lime completely from the surface, but not to neutralise the whole of that present, since a trace of lime left in the interior of the hide is not prejudicial. In this case the hide as a whole will remain plump, but the individual fibres will become reduced, so that it will lose its firmness, and become soft and easily compressed. It must be specially noted that as the skin is capable of taking up acids from very dilute solutions, the effect, if time is allowed, will depend on the total quantities of acid present, and not on its concentration, so that a large volume of a dilute solution may act more powerfully than a small volume of a stronger one.

Another method which in many cases is very useful both for sole and dressing leather, is to employ an acid so feeble that it is incapable of swelling the hide, while it still can neutralise the lime. For this purpose one of the most useful acids is boric, but several organic acids have been suggested for the purpose, principally sulphonic derivatives of the aromatic series. Much more might be profitably said on this subject if time allowed. Salts of ammonia may be usefully employed to remove lime with liberation of ammonia, which has much less swelling power, and is more easily removed by washing. The addition of ammonium chloride to the bath used in deliming dressing leather with sulphuric acid, adds considerably to the safety of the operation, as it is unnecessary to absolutely neutralise the whole of the lime, and if sulphuric acid is accidently added in excess, the chlorides present tend to control its bad effects on the skin.

I must, however, now pass on to the fermentative methods which are still most commonly in use. The simplest of these is what is called the "bran drench," which is sometimes used alone, as in the manufacture of calf kid, but more commonly to supplement the action of the dung bates. Principally through the investigations of Mr. J. T. Wood, we are now able to explain this very completely. Hot water is poured upon bran, and the mixture is set with a few pailsful of a fermenting drench liquor, and the skins are placed in the liquid, which is generally maintained at a temperature of about 70° Fahr. Fermentation soon sets in, and gas is evolved, which floats the skins up to the surface, and at the same time lactic and acetic acids are formed, which act upon the lime. The skins are put down into the liquor again, but soon rise a second time, and when this has taken place two or three times, which may occur in 12 to 16 hours, the action is generally sufficient. Mr. Wood has isolated the principal bacteria concerned in this fermentation, which he has named *Bacterium furfuris* α and β. He finds that either of these organisms alone will produce the required effect, but that they act more satisfactorily together, and are generally both present in the drench. These organisms are in themselves incapable of fermenting the starch, which is the source of their nutriment, but which must first be converted into glucose by a zymase, cerealin, which is naturally present in the bran. The fermentation has the peculiarity that, in addition to the lactic and acetic acids, and carbon dioxide, considerable quantities of hydrogen are evolved, so that the gas can be actually inflamed. The bacteria of the drench are incapable of acting directly on the skins, and a quite similar effect is produced by the action of a very dilute solution of lactic and acetic acids, which is now sometimes substituted, with considerable gain in safety, as false ferments sometimes get the

upper hand in the ordinary drench with disastrous effect. The most dangerous of these is one which produces a sudden change from the lactic to a butyric fermentation, by which the skins are extremely swollen and rapidly dissolved. It will be noted that the bran drench, though a bacterial process, results in a simple "pulling down" and neutralising of the skins with weak acids, and they should come from it in a soft, white, and slightly plump condition. If, as is often the case, it follows the processes of puering or bating, the ferments of these processes to some extent thrive in the drench, and its effects may to a certain extent resemble that of dung bates; but in presence of glucose, the fermentation is always of an acid character, while the liquefying bacteria of the dung bate require an alkaline medium. Wood states, however, that the specific drench ferments almost certainly have originated from the dung.

Bating (abating) is a treatment in fermenting infusions of pigeon or hen dung, which is applied principally to the heavier sorts of shoe leather, such as thin ox and cow hides, calfskins, and so forth. Puering (probably from the French *puer* to stink) is a similar treatment with the excrement of dogs, and is used especially on the lighter kinds of skin, such as glove leathers and morocco, and is generally followed by a bran drench to cleanse the skins and complete the removal of the lime. In principle the two are extremely similar, and may be discussed together, though there are considerable differences both in their effect and mode of application.

In earlier years, before bacteriological effects received so much attention as they now do, attempts were made to account for the action of these processes on purely chemical grounds, but it is now recognised that the effect of the traces of ammonia salts and phosphates which are present in the solutions, are of no importance as compared to those of the products of bacteriological action, and the researches of Mr. Wood, who has done so much to clear up the theory of the bran drench, have shed much light on the present subject also. He has shown that the presence of living bacteria is unnecessary, and that in the dog puer at least, the really active agents are the enzymes or soluble unorganised ferments which bacteria have formed, and organic salts of amines or compound ammonias which have resulted from their action on the organic matter present. Each of these classes of substances has a reducing action on skin when used alone, but the proper puering action only takes place when both are present. He has separated the amines from a puer liquor by distillation with soda, and combined them with hydrochloric acid, and has precipitated the soluble ferments with strong alcohol. On dissolving these in water at the rate of ½ per cent. of each, a liquid was obtained which had precisely the same effect on skin as the original puer without any danger of injury to the skin from false ferments. He has found that similar compounds can be obtained by fermentation of a nutrient gelatine solution with other bacteria than those obtained from puer, and that the solution can be concentrated in vacuo, and kept till it is required for use; so that we may now look forward very hopefully to the complete disuse of the dangerous and disgusting processes which have long been a trouble and a disgrace to the tanner, though apparently there are practical difficulties in the manufacture of concentrated solutions on a commercial scale which have not yet been wholly overcome.

It is fair to note that Messrs. Popp and Becker, of Frankfort, have been working independently of Mr. Wood on similar lines, and both they and he have succeeded in producing artificial bacterial bating preparations identical in principle, and perfectly successful in practical use. I have recently had the opportunity of discussing the question with one of the leading technical chemists of the industry, who has tested both preparations very thoroughly, and on a large scale, in an important German leather works, and his results leave little doubt that the older processes will soon become obsolete.

In the present practice, for light skins such as kid and sheep, a liquor is made by dissolving dog dung in water at a temperature of about 90° Fahr. to a turbid solution, in which the skins are kept in gentle motion. In a short time, ranging from an hour upwards, according to circumstances, the previous plump and limy skin becomes so flaccid that the common statement that it can be drawn through a wedding ring is hardly an exaggeration, and when it is tanned, instead of producing a plump and somewhat hard leather, the product is soft, and can be stretched in any direction without springing back. The effect may be well seen in the leather of a kid glove. It is clear that something beyond mere removal of the lime has taken place, and that something, so far as we at present understand it, consists in a solution of the cementing substance of the

fibres, and in some osmotic effect which causes the swollen fibre to give up its water.

The effect of the pigeon or hen bate is less in degree than that of the puer, but so similar in character that it is hardly necessary to go into detail about it. The process generally takes place without artificial heat, and lasts four or five days, though it may be much quickened by working at the same temperature as the puer, say 90° Fahr. It is best to exhaust the material with warm water, and allow it to ferment for about a week in a separate tank, using only the clear liquor wherewith to treat the skins, as injurious bacteria are apt to be contained in the sediment, which settle into folds of the skin, and destroy its grain surface. What difference there is in the action of the bate from that of the puer may very possibly be due, in Mr. Wood's opinion, to the greater amount of urates present.

Miscellaneous.

MANUFACTURE OF MEZCAL.

Mezcal is a strong spirit prepared in Mexico from the stem of the Maguey, or *Agave Americana.* When carefully manufactured it is free from fusel oil, has a bland taste, and a slightly aperient medicinal effect. The agaves grow best on a stony, volcanic soil. After the young plants have been put out they require no attention, except occasional cutting back of the shrubby vegetation. At the end of six or seven years they are cut down, the leaves are removed, and the stem is split. A single stem makes a load for a donkey. At the hacienda the stems are steamed for twenty hours, sliced, and ground with water in a stone edge-runner mill; the pulp thus produced is fermented for six days, strained, and washed; the residue is eaten by cattle for the waste sugar it contains. The liquor is distilled, and the spirit rectified once; it matures in one year if kept at a temperature of 65° Fahr. The chief valuable constituent of the stem is a high per-centage of uncrystallisable grape-sugar, from which the alcohol is derived by fermentation. The leaves yield a large proportion of strong fibre, which can be easily separated in a machine of simple construction, and commands a ready local sale at about 2¼d. per pound, for the manufacture of ropes and sacking. The cultivation of the agave is very well suited to the dry *tierra caliente* of Mexico, as it requires little labour, and is unaffected by drought; every part of the plant is useful, even the waste cellular tissue of the leaves being a good cattle food. The profits of the industry are said to be considerable.

FORMOSAN CAMPHOR INDUSTRY.

The camphor trade, that is to say, the manufacture of camphor, for some time past in the hands of German merchants only, has ceased to be of interest to any but Chinese and Japanese, the latter having in every way more facilities for handling this article in the interior. Although from time to time reports are received of robbery with violence perpetrated by banditti up-country, most places where camphor is now manufactured can be considered as more or less quiet.

The British Consul at Tamsui, quoted in the *Board of Trade Journal*, states that since it has been decided by the Formosa Government to institute a camphor monopoly, production has materially increased, owing to the high prices ruling in Hong-Kong during the last few months.

The monopoly was to come into force on 1st July, 1899, and from that date the Government alone was to be allowed to purchase camphor from the producers. As they will only buy a certain quantity per annum, they will have absolute control of the working of camphor, together with all matters respecting the cutting down of trees, &c.

Permits will be issued to producers, and anyone having the proper concession-papers and who has taken out a license in due form, will be allowed to produce camphor.

The Government will itself undertake the sale of the raw camphor, after production, in its unrefined state, and will dispose of it to purchasers at certain points to be determined upon by the Government. These places will probably be Daitotei (Twatutia). Shinchiku (Tekcham), Tokoham, and the towns on the west coast where camphor has usually hitherto been deposited awaiting transport.

The Government has already fixed the price of camphor for the period from July 1st, 1899, to the end of the financial year at 30 yen (say £3) per 100 catties (say 133⅓ lb.). The Consul is of opinion that this price would seem to be too low, and that it will very probably be raised for the following reasons. If the Government buys at 30 yen at the places of production, *i.e.*, as it comes out of the stills, this would give the manufacturer only 2 or 3 yen profit, not taking account of possible and probable losses occasioned by typhoons or other causes, whilst if the Government proposes to make its purchases at Daitotei (Twatutia), Shinchiku (Tekcham), and the other places mentioned, 30 yen would be quite insufficient to give a profit after deducting expenses for cost of transport from the stills and loss in weight. This last item alone would amount to at least 10 per cent.

The present monthly export to Hong-Kong may be calculated at from 2,000 to 2,500 boxes from Tamsui, and say from 100 to 200 boxes from Kelung to Japan. Owing to the enhanced prices ruling in Hong-Kong, in anticipation of the monopoly, the total export from the island has increased by about 600 boxes a month.

TEXTILE INDUSTRIES OF SAXONY.

Work in textiles represents the major part of Saxony's industries; hundreds of persons are directly employed in their production, and they furnish occupation to the makers of machines and others. According to the census of 1895, Saxony employs 27½ per cent. of all the textile workers in the German empire, and upwards of 32·7 per cent. of all the persons employed in Saxon industries are in textiles. Many work at home on what is known as the house industries. In 1885, there were 113,341 hands in the mills; in 1890, 146,484; in 1895, 165,459. The horse-power used in the mills was, in 1886, 33,352; in 1890, 52,299; in 1895, 81,292. Almost every branch of textiles is carried on in the kingdom, but the most important is the production of middle-grade woollen and cotton goods. One great speciality is vigogne, a yarn made from a mixture of wool and cotton, or from cotton alone. The total number of spindles, including those employed in the manufacture of thread is—cotton 850,000, vigogne 600,000, carded yarns 350,000, worsted 700,000. A large quantity of Saxon yarn is sent abroad. The kingdom produces, annually, worsted yarns worth £4,760,000, and vigogne yarns worth nearly £2,000,000. The Greiz Gera district has 11,500 power-looms producing annually cloth worth upwards of £2,800,000. Fancy woollen cloths are produced on the hand-looms of Glauchau and Meerane. The annual output is valued at about £3,400,000. Flannels for women's and children's clothing are made in great quantities and varieties. Of these, £2,500,000 worth are sent to Asia, Africa, and South America. Cotton, linen, and half-linen goods go mostly to South America. The annual product is about £3,800,000. Calicoes, lace curtains, embroideries, shawls, upholstery goods, &c., are made in Saxony. The weaving industry employs about 94,500 persons. Forty thousand are employed in knitting, producing goods worth £4,760,000, divided as follows:—Hosiery, £2,900,000; gloves, £1,200,000; and underwear, £660,000. Embroideries are among the most important textile products of Saxony. In Plauen and its neighbourhood there are 2,500 of the so-called flat-stitch embroidery machines, representing about £350,000, producing annually goods worth from £1,800,000 to £2,000,000. Besides these there are 3,000 hand machines for flat-stitch work. Saxon laces and embroideries amount to nearly £3,000,000 per annum. and are produced by 16,000 persons, 10,000 of whom are employed in mills, and 6,000 in their own houses. Annaberg and its adjacent city, Buchholz, have 14,000 hands employed in trimmings and passementeries. The total product is valued at £1,200,000 annually. England, Germany, and the United States are the largest buyers. Bleaching, dyeing, printing, and finishing, adjuncts of the textile trades, have reached a very high degree of excellence in Saxony. Dyeing employs 10,000 persons. Chemnitz, the seat of the famous diamond black works of Louis Hermsdorf, employs 2,600. There are upwards of 19,000 persons engaged in bleaching, printing, and finishing.

DIAMOND PRODUCTION OF THE TRANSVAAL.

According to the United States Consul at Pretoria, the output of diamonds in the Pretoria district during 1898 amounted to 11,025 carats, valued at £8,867. In December, 1897, the output was 166 carats, valued at £146, and for the same month in 1898 the output was 3,100 carats, with a value of £2,389. The largest stone found in 1898 was 38½ carats. Although the diamond industry is not developing with abnormal rapidity there is every cause for satisfaction, the first stone having been discovered at Reitfontein only in August, 1897. The average value of stones found in the Pretoria district is 16s. per carat, the average value of Kimberley diamonds 26s. per carat, and those found at Jaggersfontein, in the Orange Free State, 34s. per carat. The diamonds in the Pretoria district are found in pipes, as on Schuller's mine and on Montrose. A similar formation has been found on Roodeplaats on the Pienaars river, and another is also reported at Kameelfontein and Buffelsduff. On the De Kroon farm, about 26 miles west of Pretoria, diamonds have been found, but according to the State geologist, not in a blue ground formation. At Byrnestpoort an alluvial deposit is being worked, also one on the adjoining portion of the Elandsfontein farm. The area of diamondiferous ground is very extensive though its thickness is not considerable. The total quantity of diamonds found in 1898 in the Transvaal was 22,843 carats, valued at £43,730. At the alluvial diggings 12,283 carats, valued at £35,228, were found; while from the pipes 10,560 carats, valued at £8,502, were obtained. The difference between alluvial and pipe diamonds consists in the fact that river stones are of a far better quality and are generally larger.

THE COCOA PALM AND ITS PRODUCTS IN THE PHILIPPINE ISLANDS.

There are several species of cocoa palms growing in the Archipelago, but the ordinary cocoanut tree (*Cocos nucifera*) is the most important. The Indians make use of it in a good many ways, but only the principal ones need be enumerated. The kernel of the nut they use for food, while the liquid the shell contains makes a refreshing drink. If allowed to stand for some time, this liquid forms a very agreeable milky juice, that is relished not only by the natives, but by Europeans as well. After this juice has coagulated, it is mixed with sugar and made into bonbons, known as cocoa sugar, and also into various other delicacies. According to a recent report of the United States Department of Agriculture, by

tapping the central bud that crowns the cocoanut, a kind of wine, called *tuba*, of an agreeable pungent taste, is produced. This *tuba*, when allowed to ferment, produces vinegar, and when distilled, a kind of brandy, that is highly relished by the natives. From the husk of the cocoanut the Tagals make ropes and cords, and a material for calking their boats. From the woody shell they carve spoons, cups, beads for rosaries, and many other articles. The leaves they use to cover the roofs of their houses. Roofs made in this manner are thick and tight, but they have the disadvantage of burning readily, so that in the towns and villages where the houses are thus covered, conflagrations spread with great rapidity. The veins and smaller ribs of the leaves are used to make brooms, the midribs serve as fuel, and the ashes are utilised in making soap. The trunk of the palm is made to serve as a pillar to support the houses that its leaves overshadow. Oil barrels, *tuba* casks, and water-pipes are fashioned from hollow sections of the trunk. From the roots the natives extract a red dyeing material, that they chew in place of the areca palm nuts or *bonga* when the latter cannot be procured. Large quantities of cocoanut oil are manufactured in the Philippines. This oil is much prized by the natives. The men and women both use it to anoint the thick growth of hair that adorns their heads, and it thus finds a ready sale at remunerative prices. It is also used in the lamps that take the place of gas-burners in the streets, and in those used by the natives and Chinese in their houses. Manila exports annually about 150,000 pesos (£25,000) worth of cocoanuts to China and British India, and about 30,000 pesos (£5,000) worth of cocoanut oil to China.

General Notes.

Recent Applications of Electro-Metallurgy.—In a paper on this subject, read before the British Association by Mr. Cowper-Coles, an electrolytic process for the manufacture of reflectors was described, suitable for making parabolic reflectors for search-lights. The process consists in using a glass convex mould, on which is chemically deposited a coating of metallic silver. The mould thus prepared is immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position, the number of revolutions being about fifteen per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120° Fahr., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould; it has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent it tarnishing. Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness. Palladium resists tarnishing and the heat of the arc to a wonderful degree.

Armoured Glass.—Glass plates cast with wire gauze, or rather mesh, enclosed in its substance, submitted to tests at the Chemnitz Technical Institute and the Vienna Technological Museum, were found to possess great consistency as well as resistance to pressure, shock, and the effects of heat, the resistance being 25·5 kilogrammes per square centimetre (361 lbs. per square inch), and the consistency 255·12 kilogrammes per square centimetre (3,610 lbs. per square inch) of the transverse sectional area. While plates of ordinary glass frequently broke under the sudden application of pressure, the strengthened glass was only cracked; and the cracks caused by rapid changes of temperature permitted neither damp nor flame to pass. It has already been proposed to use the strengthened glass for protecting water-gauge tubes; and the above-named qualities would seem to indicate its use for the glasses of safety lamps.

German Sugar Production, 1898–99.—According to a statement published in the *Reichsanzeiger*, of August 12th, the quantity of refined and manufactured sugar produced in Germany during the campaign year 1898-99 (August 1st, 1898, to July 31st, 1899) was 1,186,686 tons, as compared with 1,207,350 tons during the campaign 1897-98. The quantity of raw sugar produced was 1,515,526 tons in 1898–99, against 1,664,268 in the preceding sugar campaign. The quantity of raw beets used in sugar manufacture is stated to have been 12,144,291 tons in 1898-99, and 13,697,891 tons in 1897–98.

Polish Geese Markets.—It is not generally known that a regular "goose market" is held at Warsaw during the month of October, through which some 3,000,000 geese pass, some for consumption at Warsaw, but most for export to Germany. One-third of the geese come from the Government of Vilna, and many more have come long distances, which would ruin their feet, to prevent which they are "shod," as it is called, before setting out on their journey to Warsaw, that is, they are driven first through tar poured on the ground, and then through sand. After the operation has been repeated several times, their feet become covered with a hard crust which protects them during their long march on hard ground. Formerly, almost all the geese were brought to Warsaw alive, but latterly, thanks to quicker means of transport, comparatively few, as it is found cheaper to have them on the market ready killed. Enormous numbers of geese are also sent direct from various points in the country, by road or rail, to Germany; for instance, from one small station 300 railway-waggon loads are sent yearly.

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CANTOR LECTURES.

THE MANUFACTURE OF LEATHER.

By Prof. Henry R. Procter.

LECTURE III.—Delivered May 1, 1899.

In the preceding lectures we have discussed the character of the hides and skins from which leather is made, and their treatment preparatory to tanning. We must now pause to ask ourselves the precise meaning of the word "leather," and the nature of the change which takes place in its production from the raw skin.

While skin is easily putrescible, leather is one of the most imperishable of animal products; and while dried skin is hard and horny, and almost impermeable to air, leather is flexible and porous. The essential points, then, are the resistance to decay, and the soft and porous character of the material, though the latter qualities are present in a greater or less degree, according to the process of manufacture and the purpose for which the leather is intended. We have seen that the moist and raw skin consists, practically, of gelatinous fibres, distended with water, soft, and more or less sticky; and it is obvious that when such a material dries, the fibres will adhere together and contract into a rigid and horny mass, impervious to air, and translucent to light because of its solid and comparatively homogeneous character.

Our first aim, then, in attempting its conversion into leather must be to prevent the adhesion of the fibres which, individually, from their tenuity, are flexible enough. We may accomplish this in a variety of ways. Most simply, we may replace the water between the fibres by some liquid in which they are insoluble, and which will absorb and withdraw the water with which they are swollen, thus allowing them to shrink and harden without adhesion, and without producing any chemical change in the fibres themselves. We may render this result permanent by producing chemical changes in the fibres which render them insoluble in water, and prevent their swelling; or we may simply coat their surfaces with an insoluble and, consequently, non-adhesive layer. The merit of having first clearly seen and expressed these essential principles in leather production belongs to the now venerable Professor Knapp, who, in 1858, in a paper of 30 pages, entitled "Natur und Wesen der Gerberei und des Leders," published a mass of practical experiment and clear explanation, which has been a mine for tanning inventors ever since. In it, for instance, the latest process of chrome tanning was not only anticipated, but clearly described, so that if its value had been understood it could have been worked 40 years ago as well as to-day.

Knapp showed that a piece of raw skin prepared for tanning, if suspended in absolute alcohol frequently renewed so as to maintain its strength, was converted into white leather, not distinguishable in feel or appearance from ordinary alumed leather, such as is used for capping druggists' bottles. We have here a leather in which no chemical change has taken place, and which on thorough soaking in water returns to the condition of raw pelt. The change is a purely physical one, and the principles involved are so important to a clear understanding of our subject, that it is necessary to consider it in some detail. We have to deal here with the nature of jellies, and the causes which lead to the swelling of colloid bodies by absorption of liquids, and the converse—a question which has hardly received the attention from physicists which its inherent interest and its cardinal importance to biologists deserves. It enters into the explanation of every stage of the tanning process, from the soaking of the raw skin to its final conversion into leather. The jelly state has been well defined in a recent paper by Pauli (Pascheles) as "one in which a solid body has taken up a liquid without itself losing the solid state, while the absorbed substance still acts in many ways as a liquid." A jelly is in fact a typical case of "solid solution:" and as, in solutions in general, we may consider either of the two bodies concerned as the solvent or the dissolved substance, the whole question resolves itself into one of mutual solubility. There are many liquids, as for instance ether and water, which, when shaken together, do not mix, but have a limited mutual solubility. In the case named, the water dissolves a little ether, and the ether dissolves a portion of

water, but the two solutions separate from each other as soon as the shaking is discontinued. Their strengths are such that the solution-pressures of ether and water in both solutions are in equilibrium with each other; so that there is no tendency for either ether or water to pass out of the water-ether into the ether-water solution or *vice versa*. If now we introduce a third substance, say potassium carbonate, which is soluble in water but not in ether, into the water-ether layer, it will dissolve with, and satisfy the attraction of a portion of the water molecules, the outward solution-pressure of the water in that layer will be diminished, water will diffuse into it from the ether-water layer to restore the equilibrium, and the ether will become more concentrated and smaller in volume.

If a sheet of dry gelatine be suspended in water, it will absorb water and swell till equilibrium is reached, the attraction of water for the gelatine molecules at that dilution being equal to the attraction of water molecules for each other (and for the very small quantity of gelatine molecules which become dissolved in the outside solution). If we add a third substance, say alcohol, which has a strong solution-attraction for water (as evidenced by the contraction of volume, and the heat evolved when they are mixed), but is scarcely soluble in gelatine or gelatine jelly, the outward pressure of the external water is of course diminished, water passes out of the jelly to restore the equilibrium, and the jelly contracts. The close analogy of the two cases is obvious. If we concentrate our alcohol outside, we may almost completely dehydrate the jelly, and if we add sufficient excess of alcohol to a warm aqueous gelatine solution, we may quantitatively separate the gelatine as a firm elastic mass. The action of the alcohol in converting the raw pelt into leather is now clear—it first takes the place of the water in the spaces which separate the fibres, and then dehydrates and hardens the latter, so that in drying no adhesion takes place, or one so slight only, that it is easily overcome by a little mechanica stretching.

If gelatine or well washed pelt be immersed in a solution of common salt, it becomes somewhat more swollen than in water. The salt lowers the solution-pressure of the water, but as the presence of gelatine does not affect its solubility, the concentration of the salt solution contained in the swollen gelatine is precisely the same as that outside, and there is no tendency for water to pass outwards. On the other hand, as the affinity of the water is partially satisfied by the salt, a larger volume is required to bring it into equilibrium with the gelatine, which therefore swells. Some salts, however, as for instance ammonium sulphate in strong solution, dehydrate the gelatine almost like alcohol, though, according to Hofmeister, all salt solutions have some special concentration at which they produce a maximum swelling greater than that of pure water. Doubtless these peculiarities correspond to differences of solubility of the salt in the gelatine which for the present we cannot explain, but must be content to regard as properties of the materials.

If gelatine or raw skin be placed in a dilute solution of any acid it becomes swollen, and generally to a much larger extent than in salt solutions, and the equilibrium reached is of a more complex character. A part of the acid in the swollen jelly appears to be simply dissolved in the water absorbed, while another part is more closely united to the gelatine, and the latter part no longer obeys the simple laws of equilibrium of solutions, but acts as if it formed a weak chemical compound with the gelatine. Thus in very dilute solutions, practically the whole of the acid is taken up by the gelatine, and the external liquid may become quite neutral to the ordinary indicators. If we calculate the amount of acid fixed by the gelatine in excess of that corresponding to the volume of external solution absorbed, we shall find that it rises to a maximum with increasing concentration up to a certain point, and then slowly diminishes. A maximum swelling corresponds to the maximum of "acid fixed," and as concentration increases the swelling diminishes much more rapidly and considerably than the "acid fixed." The maximum of swelling and "acid fixed" corresponds to different concentrations with different acids, and the amount of acid fixed also varies, following no regular molecular proportion. The explanation of these facts is partly given by researches which I have now in progress, and is, I believe, to be found in considerations of chemical and physical equilibrium such as I have tried to apply in the simpler cases of alcohol and salt solutions, but it is, at any rate, too complex to discuss in detail in the present lectures.

We have seen that both acid and common salt solutions produce swelling of the hide fibre, but when we experiment with both together we meet with an astonishing phenomenon—instead of getting a swelling, which is the sum

of the two effects, we get an intense dehydration and contraction, equal to that produced by strong alcohol—the addition of salt to a dilute acid solution, such as will produce a maximum swelling, will precipitate gelatine from its solution, and dry up swollen jelly to a firm and almost hard condition: the water in the jelly being reduced from perhaps 40 times the weight of the air-dry gelatine used to about its own weight. A quite similar, and probably equally powerful effect is produced on actual skin. We may get some hint of the causes at work if we reflect that even with hydrochloric acid alone, as we increase its quantity we easily pass the concentration of maximum swelling, and begin to get contraction, though the experiment cannot be carried very far on account of the direct solvent effect of strong acids on gelatine jelly. I am inclined to think that both the swelling and the subsequent contraction are due to the necessity of an equilibrium between the Cl ions of the hydrochloric acid in the outside solution and those of the much less ionised hydrochloric acid "fixed" by the gelatine, the much lower ionisation of the acid fixed being proved by the fact that it no longer changes the colour of methyl orange. Now, if this be the true explanation, it is easy to see that if the solution outside be saturated with the highly ionised sodium chloride, which is not in any degree "fixed" by the gelatine, though it freely diffuses through the water in the jelly, the acid gelatine must contract and become more concentrated in order to establish an equilibrium with the abundant chlorine ions outside. At the same time the proportion of acid "fixed" by the gelatine becomes increased by the same cause.

Similar effects are produced by sulphates in presence of sulphuric acid, and indeed by any acid in presence of large quantities of common salt. The latter is indeed to be expected, since the law of mass action teaches that under such circumstances the acid fixed by the gelatine must be mainly hydrochloric.

I now pass on from these theoretical considerations to an important technical application. Sheepskins, unwooled and prepared for tanning, are preserved for exportation by what is known as "pickling" with solutions of sulphuric acid and salt, in this condition they are brought from New Zealand and Australia, and are shipped largely to the United States. The pelts, after liming, puering, and drenching, are first paddled in a very dilute solution of sulphuric acid to which a portion of salt is added to control the swelling, and are then brought into a strong brine, in which they become white and flat, and can now be packed wet in casks, and preserved for months without change. If the skins in this condition are dried out, they are found to be converted into a white leather, which, after stretching and softening by "staking" (drawing over a blunt steel blade fixed on a post), are indistinguishable in appearance from ordinary alumed leather, and indeed have been sold for such.

We have seen that the joint action of acid and salt dehydrates gelatine as alcohol does, and we now see that it is also capable of converting the raw skin into leather. The principle is, in fact, used in preparing lambskins for use instead of furs in Eastern Europe. The raw skins are covered with a mixture of rye meal and brine, and allowed to lie in tubs till the meal ferments, when the lactic acid formed brings about the effect which I have described. It was formerly supposed that the function of the brine in the pickling process was to remove the acid, but it is shown by analysis that unless great excess of acid has been used no trace of acid diffuses into the strong brine, but that any present in it is taken up by the skins. The effect of excess of acid is gradually to rot the skins, as they will take up much more acid than is necessary for their preservation, and, indeed, I have effectively pickled skin with 1-10th of the acid generally used. So far as I can judge from laboratory experiments, the process may be simplified and improved by introducing the skins at once into saturated brine in a paddle vat, and gradually adding a calculated quantity of acid which is all taken up by the skins. If pickled skins are placed in water the salt diffuses out, while the acid is retained, and causes them to swell up enormously; and it is therefore necessary to begin the tanning process in sumach liquors, which contain a large per-centage of salt. If no more than the really requisite quantity of acid is used it is possible to tan the skins even in unsalted liquors, and a very little salt to begin with is all that is required. Instead of using salted liquors, the acid may be neutralised with chalk or borax before tanning.

We have now some facts before us which will help us to understand the function of salt in the ordinary process of making alumed and chrome leathers. It will be shown, when we come to consider the tanning effect of salts of the alumina group, that the compound really fixed upon the skin is a very basic salt of the metal, or more probably even the oxide itself.

Now these metals in the trivalent state are very weak bases; so much so that the hydrochloric acid may be split off from ferric chloride even by dialysis through parchment paper, leaving at last only a solution of colloid ferric oxide. We should, therefore, expect that the well-known attraction of hide fibre for acids would be sufficient to decompose these salts, and that the fibre would become swollen with the acid, while some proportion of the base would also be fixed. The facts justify our conclusion. With normal ferric chloride the fibre is so swollen that only rotten leather results, and though with alumina salts the swelling is not so considerable, only a hard and useless leather can be made with alum or alumina sulphate alone, while the quantity of base fixed is not very large. When, however, we add salt to the mixture, the swelling is prevented, and the acid is taken up and fixed in larger quantity, and at the same time a much larger quantity of the base is absorbed, so that we have a leather which we may consider as being partially really tanned by alumina, and partially by "pickling." If we make our alumina salt basic in the first place by "neutralising" with an alkali, the salt is no longer essential; and in the case of chrome at least, it is practicable, after tanning in a solution of a basic salt, to remove practically the whole of the acid from the fibre by treatment with a weak alkali, with improvement to the quality and permanence of the leather.

No complete explanation can yet be offered of the tanning effect of the trivalent salts of the iron and alumina group, though the subject has been investigated by Knapp, Reimer, and others. Mills and Sawers (Jour. Soc. Ch. Ind., 1895, p. 252) analysed the products formed by acting on gelatine jelly with some chromium and aluminium salts, and give empirical formulæ, but their composition is so varied that it is hard to resist the conclusion that they are rather results of physical equilibrium than true chemical compounds. Not merely the amount of the absorbed chromium and aluminium, but the basicity of the absorbed salt varies under different conditions, and there is nothing to contradict the suggestion that the oxide or hydrate rather than any particular basic salt is the essential tanning substance. This view is also supported by the fact so much utilised in photography, that chromic acid and the bichromates render gelatine insoluble when reduced by the action of light in absence of any acid, and that skins may be tanned by chromic acid subsequently reduced by alkaline sulphides.

It is only the M_2O_3 salts of these metals which will tan; neither chromic acid nor ferrous salts having that power, though they may both be used as a means of producing the required compounds in the skin. As neither manganese nor zinc form stable oxysalts of the required constitution, they seem to have little tanning effect.

In practice, tanning, or as it is generally called "tawing," with alumina salts, is nearly always done with solutions of alum, or normal alumina sulphate, with addition of common salt, although the use of basic salts formed by neutralising a part of the acid with an alkali offers some advantages, and was made the subject of a patent by Bertram Hunt, which has now expired. The method was proposed and described in 1858 by Knapp, with regard to iron and chrome salts, though he does not seem to have thought it necessary to apply it to aluminium salts.

The large German tanners of calf-kid have for some time abandoned the use of alum for that of aluminium sulphate, which is cheaper and more effective, as the sulphate of potash or ammonium in the former takes no part in the tawing process, and the sole advantage of alum is that in earlier times it was easier to obtain in a state of comparative purity. English tanners, however, still continue to a considerable extent to employ alum. The quantity of salt which is used is rather variable, but roughly amounts to about half the weight of the alum, though much more may be used without it in any way preventing the tawing. The strength of solution varies widely for different sorts of leather—sheepskins are alumed for rugs by applying a strong warm solution (containing say 15 per cent. of alum, and 10 per cent. of salt) repeatedly to the flesh side of the skin stretched on a frame, or in some cases even by rubbing powdered alum and salt into the wet skin, while in some sorts of lace leathers where something of a "raw hide" character is desired in the finished product, very weak solutions may be used; but for most purposes about 10 per cent. of alum and 5 per cent. of salt may be considered an average strength.

Alum and salt alone is only used on the cheaper sorts of leather; while for the finer white leathers, such as glove-kid and calf-kid, they are employed in a paste with flour and egg yolk, with generally some addition of olive oil. In the old-fashioned manufacture,

the paste was trodden into the skins by men with bare feet in a round tub, but in the present day, this primitive method is superseded by drums, like large barrel churns, into which the skins are placed with the tawing paste. In the case of glove-kid, the process is complete in about an hour and a-half, the skins being drummed three times for twenty minutes, with ten minutes rests, after which they are hung up to dry with the adhering paste. The quantities of egg yolk which are used in this manufacture are very large. A Leeds manufacturer of calf-kid told me that his firm alone consumed about sixty tons a year of preserved yolk, equal to, say, 3,000,000 eggs! Probably two or three times 60 tons of flour would be used, and the firm I refer to is only one out of several, so that the consumption of valuable foodstuffs is very considerable, and a pair of kid boots properly cooked might prove very valuable in extremities. It is much to be desired that cheaper substitutes could be found — the egg yolk is mainly useful on account of the very finely emulsified oil which it contains and for its albumen; the flour serves as a further source of albuminous matter by its gluten, while no large portion of the starch is absorbed. There is apparently nothing very special in the character of egg oil, which could be closely imitated by a mixture of olive oil with a little palm oil. Other albuminous matters are also capable of producing the same effect as the eggs, so that the problem is principally to find a cheap source of suitable albuminous matter, and to mix it sufficiently intimately with the oil. The casein of separated milk, and the finely ground kernels of some oily nuts are likely materials. Some compositions have been made which produced fairly satisfactory leathers, but unfortunately they were not materially cheaper than the materials at present in use. The albuminous matter is mechanically forced into the leather by the treading or drumming, and is fixed there by being tawed along with the skin fibre by the joint action of the alum and the oil. The oil serves not merely to give softness to the leather by lubricating the fibre, but takes part in the conversion of it into leather, and materially adds to its resistance to water.

After the skins are dried out of the tawing paste they are dipped for a moment in water, and allowed to lie in a damp place till they are somewhat softened, when they are trodden or lightly stocked, and afterwards stretched by drawing over a blade fixed on a post, an operation which is known as "staking;" or, in some cases, they are fixed on a horizontal bar known as a "perch," and softened with a tool shaped somewhat like a shovel, which is called a "crutch stake." In the case of calf-kid this work is now generally done by machines. As the skin dries the process is repeated, producing a soft white leather, much like white glove leather. In this state, or sometimes before staking, it is stored in well-ventilated warehouses, for some weeks at least, to "age," which appears to effect a more intimate combination between the skin fibre and the tawing materials. It is now ready to be finished, but before it can be dyed it must be freed from its superfluous salt and alum by washing with water, and this, at the same time, removes a good deal of the egg, which must be replaced by re-egging, a process

Fig. 13.

Staking Alumed Leather.

which takes place before dyeing, when this is done by brushing the dyes on a table, but after it when the dyeing is done by dipping in a tray.

Alum-tawed leather does not resist the action of water for any great length of time, and by persistent washing most of the alumina may be removed, so that the alumed leathers are still available for the production of size or gelatine. Attempts made by Knapp to render the tannage more permanent by complete neutralisation of the acid present, and the fixation of the alumina as oxide were not successful, complete neutralisation apparently destroying the tanning effect; but he was more successful by converting the alumina compound fixed into an insoluble alumina soap. "Castor" or "Nappa" leather is now made in the United States by a method based on this principle,

and not only possesses considerable resistance to water, but is very tough.

Iron salts have not attained any commercial importance as tanning agents, though iron-alum, the double ferric potassic sulphate analogous in structure to common alum, has similar tanning properties, and, in conjunction with salt, produces a soft and pliable leather which, but for its colour, might in most cases be substituted for that made with alumina if the saving in cost were of sufficient importance. Knapp made many attempts to produce a practical sole leather with basic ferric salts; but though these are absorbed in large quantities by the raw hide, the product is thin and somewhat brittle, and not capable of competing with vegetable tannages. It is, however, quite possible that the problem may yet be successfully solved, and its cheapness and rapidity would then make the process one of commercial value.

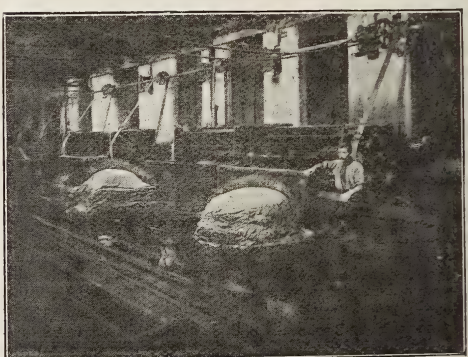
Chrome, in this respect, now occupies a very different position to iron, since leathers tanned with its salts have been found to possess valuable properties not shared by any others. Chrome leathers, when rightly manufactured, are exceedingly soft, tough, and flexible, and the tannage is very fast, and completely resistant to water, even at a boiling temperature. Chrome leathers are often spoken of as "waterproof," but this is calculated to convey a wrong impression, since in their natural state they are porous, and easily permeated by water, although the fibres themselves remain unswollen. If desired, a considerable amount of actual waterproofness may be conferred on the leather by impregnating it with fats and insoluble soaps, but when this is not done, it is perfectly permeable by air, and the statement so often made that it is unhealthy and hot to the feet is a mere prejudice. Its most important applications so far have been to light shoe-wear in the form of black glazed kid and coloured calf, but its resistance to hot water and steam fits it for a variety of mechanical purposes, and probably for hose-pipes for steamers and fire-engines it will supersede all other sorts of leather. So far the process has not been applied successfully to sole leather, except for special purposes where its heat-resisting powers are advantageous.

Though a knowledge of the tanning powers of chromic salts is by no means new, the first process which attained any commercial success was that invented by Augustus Schultz in 1884. Schultz was employed by a firm of aniline colour dealers, and was not himself a tanner, but his attention was turned to the subject by a friend who required a leather for the covering of corset steels, which would not rust them as alumed leathers do. He hit upon the idea, probably suggested by a mordanting process applied to textiles, of saturating the raw skin with chromic acid, which like all other acids is freely absorbed by the hide fibre, and of there reducing it to chromic hydrate, or a chromic salt by the agency of sulphurous acid, or an acidified solution of sodium thiosulphate (hyposulphite of soda). He obtained a patent which he sold to a syndicate for $50,000, and after several sales at higher prices and endless litigation it now remains the property of the Patent Tanning Company.

It is interesting and curious that, long before the date of the Schultz patent, Professor Hummel, of the Yorkshire College, reduced the chromic acid of a piece of leather produced by the earlier and unsuccessful Heinzerling process with sulphurous acid, in order to get rid of the unpleasant greenish-yellow colour; but the value of the suggestion was not understood, and, so far as is known, no publication took place, or the Schultz patent would have been invalidated.

The Schultz process consists in first treating the unhaired and delimed skin with a solution of about 5 per cent. of potassium bichromate, and $2\frac{1}{2}$ per cent. of commercial hydrochloric acid reckoned on the weight of the wet pelt,

Fig. 14.



Tanning Paddles.

and dissolved in enough water for convenient treatment of the skins in the paddle-vat or the drum, as the case may be, and then, when the required quantity of chromic acid has been taken up, submitting them to a solution of 10 or 12 per cent. of sodium thiosulphate, acidified

with sufficient hydrochloric acid (generally about 5 per cent. of commercial hydrochloric acid), to convert the whole of the absorbed chromic acid into bluish-green chromic salt by reduction. The excess of acid retained by the fibre is then removed by treatment with a weakly alkaline solution, usually of borax. The process is thus, apparently, very simple in theory, but in practice considerable skill is required to yield thoroughly satisfactory results, and it cannot be said that the causes of all the variations which are apt to occur have been thoroughly mastered.

In the first, or chromic-acid bath, the chromic acid has no direct tanning effect on the skin, and is probably absorbed simply as all acids are absorbed, by gelatinous fibres. In a mixture of bichromate and free chromic acid, practically only the latter is absorbed, and the bath is exhausted, leaving neutral bichromate only; yet a bath of chromic acid alone is not found to give commercially satisfactory results, and the best are only obtained in presence of a considerable quantity of undecomposed bichromate. In this connection we may remember the effect of the presence of common salt in modifying the action of hydrochloric acid in the pickling of skins, and the similar action of sulphates on that of sulphuric acid. It is to be borne in mind, however, that chromic acid, unlike those just named, is a very weak acid—that is, according to modern theory, one which is little ionised in solution, while its salt, bichromate, like all other salts, ionises much more freely. It is pointed out by Ostwald that, under these circumstances, the effect of the presence of its salt in solution is still further to depress the ionisation of the weak acid, that is, to still further weaken its acid properties, but while it is pretty evident that these are the causes we have to consider, it is not easy to "visualise" clearly what takes place. Common salt is sometimes added to the solution, which tends to make a thinner and flatter leather, and, as I have proved by direct experiment, also enables the skin to take up some portion of chromic acid even from undecomposed bichromate; and as salt, or at least potassium chloride, is always present where hydrochloric acid is used to set free the chromic acid, the reaction becomes somewhat complex. Where alum is used, as it was in the earlier Heinzerling process in conjunction with bichromate, its sulphuric acid liberates a portion of chromic acid with formation of a basic alumina salt, and still further increases the difficulty of understanding exactly what happens. Though, in conjunction with Mr. Carlton Heal (Jour. Soc. Ch. Ind., 1895, p. 248, and "Leather Industries Laboratory Book," p. 143), I have given methods which enable simple mixtures of acid and bichromate to be analysed with sufficient accuracy, they break down in presence of salts of alumina and chromic oxide. In consequence of these difficulties it has been almost impossible exactly to restore a used bichromate liquor to its original strength in acid and undecomposed salt, and many manufacturers have run these liquors to waste, still containing a large percentage of bichromate, rather than risk making a less satisfactory leather by their use. Little risk is, however, incurred by using at least a portion of old liquor a second time after strengthening. Practice varies as to whether the whole of the calculated quantity of acid should be added at once, or gradually during the process of tanning, but in my experience the latter is the better method.

When the skins come out of the chrome bath the surplus bichromate solution must be removed from them, either by draining well or by pressure, the Vaughan "putting out" machine being frequently employed for the purpose, and they are then ready for reduction. In the interval between the two baths the skins must be protected from light, which would reduce the chromic acid at the expense of the organic matter of the skin itself.

It is impossible to calculate the actual amount of thiosulphate required to reduce the chromic acid absorbed in the skin, as, without analysis either of the skin or the residual liquors, the actual quantity which it has taken up is unknown, and tanners are therefore generally content to use the reducing agent in excess. Even if the quantity were ascertained, the reaction is a somewhat uncertain one, and depends on a number of small conditions which cannot be strictly controlled. Neutral thiosulphate is incapable of producing any complete or satisfactory reduction, and when acid is added thiosulphuric acid is first set free, and then rapidly breaks up into sulphurous acid and free sulphur, thus:—

$$Na_2S_2O_3 + 2HCl = 2NaCl + H_2S_2O_3.$$
$$H_2S_2O_3 = S + H_2SO_3.$$

Tetrathionic acid is also formed as an intermediate stage of reduction. In the presence of chromic acid but little sulphurous acid is evolved, or free sulphur precipitated, and consequently a given weight of thiosulphate will do a larger amount of

reduction under these circumstances than it will if the thiosulphuric acid is first liberated and decomposed. It is, therefore, most economical in "hypo" to add the acid gradually during the reduction, and there is less tendency to "draw the grain of the leather" (*i.e.*, to make it run into wrinkles through unequal contraction), but, on the other hand, a part of the chromic acid is apt to bleed out before it can be reduced, and thus produce underchroming and waste. Some manufacturers try to overcome the difficulty by drawing the skins first through a strong hypo liquor well acidified, in order to fix the chromic acid near the surface, and then complete the reduction in less acid baths. Probably the best way is to use the full required quantity of hypo at first, adding enough acid to produce a decided evolution of sulphurous acid, and then add more acid in small quantities, so as to keep the bath in a constantly acid condition till the reduction is complete and the leather has become a uniform duck-egg green. If the skin is put in neutral hypo solution, it seems to lose its plumpness and produce flat leather.

As soon as the reduction is complete the skins are effectively tanned, but still retain an amount of free acid fixed in the fibre which would cause trouble in the finishing process, and probably produce shrinking and hardness in the finished leather, and which, from the attraction of the fibre for acids, cannot be removed by mere washing. They are, therefore, thoroughly washed with warm, or even hot water, and are then treated with a solution of borax (about 3 per cent. on the pelt weight) to neutralise and remove the acid. Other weakly alkaline salts, and, notably, acid sodium carbonate, may be substituted, but as chrome leathers are easily injured by excess of alkali, they are not so reliable in their action. A very large proportion of the troubles which occur in finishing chrome leather may be traced to insufficient washing and removal of acid at this stage. The borax solution apparently removes not only free acid, but most of that combined with the chrome oxide.

If the tanning has been successfully performed, the skins should now dry tolerably soft, even without staking, but are generally submitted to a further process called "fat-liquoring," to lubricate the fibre, and increase the softness and fullness of the leather. The fat-liquor consists of a milky emulsion of soap and oil in water, and was originally the alkaline liquor which had been used for washing the superfluous oil out of oil leathers. Various oils are used, as well as various soaps, but I have found a mixture of castor oil and castor-oil soap the most successful for fine coloured leathers. For coloured calf, about one-half per cent. of soap and three-fourths per cent. of oil on the weight of the wet pelt answers well, dissolved in sufficient water for convenient application in the drum. Before fat-liquoring, the skins should be partially dried by pressing or centrifugal machine, or by hanging in the air, and it is best to use the fat-liquor warm. Much of the success of the operation depends on the fineness of the emulsion formed, and the fat-liquor should therefore be made by a centrifugal emulsor, or by churning in a cylinder with a finely-perforated piston plunger. In some cases the skins are dyed before fat-liquoring, but usually afterwards, as many of the colours bleed a good deal into the alkaline liquid, and this is especially the case with the acid colours which are most successfully applied to chrome leather. In general the skins must not be allowed to dry out before dyeing, or the fibre becomes hard and unabsorbent, and will not take the dye. This difficulty may be overcome by adding glycerine or glucose to the extent of about 5 per cent. to the fat-liquor, which prevents thorough drying, while it allows the skins to be so far air-dried that the fat-liquor becomes fixed on the film, and does not interfere with even dyeing, which is one of the great difficulties of the manufacture.

The American patent rights in the Schultz process, which covered the use of hyposulphites, and of all other salts yielding sulphurous acid on acidification, have not only given rise to enormous litigation, but have led to the patenting of almost any other possible reducing agent which could be substituted. Many of these are of no practical use, but it is possible to make excellent leather by reduction with hydrosulphuric acid, either as gas or solution, and also with the alkaline polysulphides; but the normal sulphides of the alkalies, which are actually named in Norris's patent, do not make good leather from their strongly alkaline reaction, though possibly this might be overcome by the use of some weak acid to liberate the sulphuretted hydrogen. Another effect of the patent monopoly has been to draw attention to the possibility of tanning with a single solution of a basic salt of chromium, as originally proposed by Knapp.

The first attempt to introduce this commercially was made by Martin Dennis, who succeeded in getting a patent in the United

States on the ground that only basic chlorides were practically useful, a view which has since been shown to be entirely without foundation. He also obtained an English patent, which is registered under the name of his agent, Gallagher. The liquor which is covered by this specification is made by dissolving precipitated chromium hydrate in hydrochloric acid to saturation, and then adding sodium carbonate to neutralise the required amount of acid to produce a suitable basic salt. A similar basic compound may also be obtained direct from bichromate by reducing it in presence of a limited calculated quantity of hydrochloric acid, and about two years ago I published a formula for doing so by means of glucose, which produced a liquor with which successful commercial results have been obtained. My principal reason for alluding to this here is to state that I have since found that with many samples of glucose some organic compound is formed by the oxidation of the sugar if the action is carried to its limit, which produces a purplish liquor, which will not tan satisfactorily. An even more satisfactory result at a lower cost may be obtained by using ordinary chrome alum suitably neutralised with sodium carbonate, and generally used with an addition of salt. A 10 per cent. solution, with $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. of crystallised sodium carbonate, forms a suitable stock solution, and the tanning is performed by paddling the skins in a liquor which is gradually strengthened with the stock solution until the skins are completely tanned. The more completely the liquor is neutralised short of precipitation, and the fuller and finer the leather—acidity tends to hardness and short tannage, and the addition of salt to the liquor to fineness and softness and a thinner leather. The pelt, as would be expected from the explanation of mineral tannage which has already been given, fixes the more basic salts of the solution most freely, so that the residual liquor becomes acid, and generally contains some excess of chrome salt in too acid a condition to be easily absorbed, but it can be made suitable for use on another pack of goods by addition of soda in quantity insufficient to produce a permanent precipitate.

The results of the one-bath method are so certain and easy, once the proper conditions are understood, that it seems likely ultimately to supersede the two-bath process entirely. The basic chrome tannage must be followed by boraxing and fat-liquoring, as in the two-bath process.

Miscellaneous.

ROADSIDE FRUIT IN EUROPE.

The cultivation of fruit trees along the highways of France is being extended each year. The Government having first set the example, the communes in certain departments adopted this practice as a source of revenue, so that now roadside fruit cultivation has become an important branch of national industry. It is not, however, only in France that fruit trees have been planted along the roadside. The United States Consul at St. Etienne says that in Germany, Belgium, and the Duchy of Luxemburg, the system has been greatly developed, giving satisfaction to the State as well as to local interests. On the Wurtemburg roads, for instance, the fruit harvest from this source produced in 1878 over £40,000, and last year the returns had more than trebled. The annual revenue derived from the national roads of Saxony planted with fruit trees, rose from £1,800 in 1880 to £8,400 in 1892, furnishing a total sum of £68,000 for the 13 years. In Belgium, according to the statistics of 1894, over 2,875 miles of roads were planted with 741,571 fruit trees, which furnished the large sum of £400,000. In France the production of fruit trees is estimated at £12,000,000. In Westphalia, in the Duchies of Baden and Saxe Weimar, in Alsace-Loraine, Switzerland, &c., the *employés* of the Administration of Roads and Bridges and the road supervisors, are instructed in fruit culture. In some of the southern departments of France the roads are bordered with cherry trees, producing the small fruit called *merise* (wild cherry), much appreciated for making wine *sui generis*, preserves, and even alcohol. In the Touraine, plum trees predominate, while in the Allier, the walnut trees transform the roads into shady walks. In Auvergne the chestnut tree flourishes; while in Normandy, place is naturally given to the apple tree. Some twenty years ago, the picturesque roads of the north-east of France were lined with stately poplars; but although ornamental, their roots went far and wide, rendering the adjacent meadows sterile, and ploughs were continually stopped by offshoots lying almost at the surface of the soil. The farmers appealed in such strong terms, that the communes decided upon the fall of the poplar, and soon axes and saws were brought into requisition, and the roads cleared of these trees in favour of the humble but more useful *mirabelle* (small plum), to the great satisfaction of the villagers. Thousands of baskets of this fruit are sent to Paris daily. Some thirty years ago the distillation of the mirabelle was unknown in the country districts, the people plucked it as food for their pigs, but to-day they have learned to make more profitable use of it. They distil it in large quantities, and find a ready market for it. A quart of this alcohol, slightly perfumed, sold five or six years ago for only about

10d. or 15d., to-day it brings not less than 2s. or 2s. 6d., while in Paris, the best kind cannot be obtained under about 4s. 3d.

THE RESOURCES OF ASIATIC RUSSIA.

Siberia and the Amur lands are rich beyond belief. Their 5,214,000 square miles are inhabited by only 4,000,000 souls. In recent years, however, the number of immigrants (400,000 in 1898) has been equalled only by the tide which poured into the United States in the past. The United States Consul at Chemnitz says that this vast territory, long looked upon as a barren waste, is destined to be one of the world's richest and most productive sections. In northern France wheat ripens in 137 days; in Siberia in 107. Even severe night-frosts do not injure the young seed. Oats required in Siberia, and in the Amur country, only 96 days, and in the region of the Yenisei only 107 to ripen. The frost period lasts only 97 days in Irkutsk country. Transbaikalia lies entirely within the agricultural regions, so, too, almost the entire territory traversed by the Amur, as far north as it runs. Efforts are being made to obtain along the Amur at least 116,000 square miles for the higher form of northern agriculture. Climatically, the best of Northern Asia's territory, for planting purposes, is the Usuri country, which, in spite of its vast tracks of wood and grazing lands, has 75,000 square miles of arable land. The building of the Trans-Siberian Railway has already added to the empire's wheat product. The mineral resources of Western Siberia are vast. Between Tomsk and Kooznesk lie 23,000 square miles of coal lands which have never been touched. The coal is said to be excellent. In Eastern Siberia, with its 108,000 square miles of fruitful soil, there are 400 places yielding gold. Rich mineral deposits—graphite, lapis-lazuli—iron mines particularly rich in quality, hard and soft coal—await hands willing to work for them. Russia's output in gold and silver is already very large, and is constantly increasing. Three-fourths of all the silver found in Russia is obtained in the Altai Mountains. Exclusive of the Ural gold-fields, there are 851 places in the empire where gold is found. Notwithstanding the number of places in which iron is found, there are only four large establishments for its production. The ores are rich—58 to 60 per cent. of raw iron. The industries of Siberia are in their infancy—still, they are growing, and are bound to grow, so rich are the rewards promised. Chemical, sugar, and paper mills have been put up in several places, and are paying well. Even Manchuria is looking to Russia for its future development. The wealth of this province, like that of Siberia and all eastern Russia, is ripe for harvesting. The traffic in Siberia and eastern Russia is, according to Consul Monaghan, increasing faster than even the advocates of the Great Trans-Siberian road anticipated. The Ob, one of the world's great rivers, emptying through the gulf of Ob into the Arctic Ocean, has 102 steamers and 200 tugs running already. On the Yenisei ten steamers carry the mails regularly. The mouths of both these rivers were visited last summer by English and Russian ships. This proves the practicability of connecting eastern and western Siberia with Europe by water. The mouth of the Ob is to be deepened and wharves are to be built. On the coast of the Usuri country there is regular postal communication between Nicolajevsk, Vladivostock, and intervening places, as well as connection with Japanese ports and Port Arthur. From Odessa and St. Petersburg to various Asiatic ports runs the so-called volunteer fleet, established in 1878. It has fourteen steamers with 115,500 tons displacement. Siberia and the Amur country possess advantages very similar to those of North America, Australia, and parts of Africa. The great gain to Russia at present in developing Siberia is the guarantee that her harvests will come nearer to supplying her wheat requirements.

PAWNBROKING IN GERMANY.

In Germany, the pawnshops which originated in the 17th and 18th centuries were mostly public undertakings, conducted by the State or municipality. At the present time there still exist in the German empire the following State institutions:—The Royal Lending House in Berlin, the Grand Ducal Lending Houses in Weimar and Eisenach, the Ducal Lending House in Gotha, and the lending houses of the Ducal Brunswick Government in six cities in Brunswick. The governmental department of Cassel also maintains pawnshops in Cassel, Hanan, and Fulda. The pawnshops which originated in Napoleon's time in Strasburg and Metz, as well as those of Mainz and Mannheim, are institutions with independent government, in which, however, the city officials participate. The United States Vice-Consul at Cologne, in a recent report, gives a list of the municipal pawn institutions in Germany. The list is as follows. (1.) In Prussia:—Altona, Barmen, Bonn, Breslau, Bromberg, Celle, Coblenz, Cologne, Crefeld, Danzig, Dortmund, Düsseldorf, Duisburg, Elberfeld, Elbing, Erfurt, Essen, Frankfort, Görlitz, Halberstad, Halle, Hanover, Hildesheim, Königsberg, Leignitz, and Muhlhausen. (2.) In Thuringia:—Munich, Gladbach, Osnabrück, Posen, Schleswig, Stralsund, Trier, and Wiesbaden. (3.) In the South German States:—Augsburg, Bamberg, Bayreuth, Darmstadt, Freiburg, Fürth, Heidelberg, Karlsruhe, Nuremburg, Offenbach, Regensburg, and Würzburg. (4.) The North German States (exclusive of Prussia):—Altenburg, Chemnitz, Dresden, Gera, Hamburg, Leipzig, Lubeck, and Schwerin. Of German cities of more than 100,000 inhabitants, Magdeburg (since 1891), Bremen, Stettin, and Aix la Chapelle (since 1858) have no public pawnshops. On the whole, the number of these institutions is larger in Germany

than in France, but less than in Belgium, Holland, and Italy. Of the larger cities, Berlin has three offices, Munich four, Hamburg three, and Dresden two, for conducting this business. In several cities, the pledges can be made in sub-offices, and in some other cities, such as Cologne, they may be made to specially licensed persons. The business of pawnshops in the last three years appears, as far as can be estimated in the absence of uniform statistics, to depend less on general economic, than on special local causes. The erection of new sub-offices, as well as the decrease of the number of private pawnshops, is usually accompanied by an increase of business, while an increase in the private establishments is accompanied by a diminution in the public institutions. The capital for carrying on the business by the municipal authorities is derived from the city treasury or the city savings bank, which is usually worked in connection with the pawnshop. The cities of Munich, Augsburg, Frankfort-on-the-Main, Strasburg, and Metz make use of money borrowed from private persons at from 3 to 4 per cent. Besides these public, State, and municipal pawnshops, private business has developed to a large extent. Formerly, the German law allowed private persons to engage in this business only by special permission, and exercised strict control over them. These stringent regulations were enacted by the Prussian Trade Law in January, 1845. The projected trade regulations for the North German Confederation also insisted upon the necessity of a license. This proposal was, however, not sanctioned by the Diet, but a regulation was passed to the effect that persons who had been punished for a crime committed from avaricious motives could be prohibited from carrying on the pawnbroking business. The right was further conceded to the head officials to regulate the manner in which the pawnbrokers should keep their books, and the control of the police. These regulations in practice proved insufficient. Owing to the fact that private persons were allowed to engage in the business it increased in a manner previously unknown. In many cases it was carried on by persons of doubtful character, and by those who had been repeatedly punished by the law, if the offences for which they had been convicted were not of a nature to prohibit them from obtaining a license. The business methods of these people were often extremely onerous to those obliged to seek assistance in this direction; in some places the interest charged was more than 10 per cent. per month, or 120 per cent. per annum. All these irregularities were corrected by the statute of July 23rd, 1879, which is now the basis for the existing law for the German Empire. By this enactment those engaged in the pawnbroking business are obliged to have a license, and it is refused to people clearly proved to be unfitted for such business. Furthermore, the issuing of a license is dependent upon the fact that there is a necessity for such an institution. The supervision of the manner of conducting this business has been made more strict. Where there are no special local rules the central authorities are empowered to issue orders regulating the extent of the powers and obligations as well as the manner of carrying on the business of the pawnbrokers. The above-mentioned Imperial laws have been supplemented by special laws of the various German States. For example, the Prussian law of March 17th, 1881, determines a maximum rate of interest to be charged, compels the pawnbrokers to keep records of all the business transacted by them, and prescribes that the unredeemed pledges shall be sold at public auction. The number of private pawnshops in the German Empire is about 1,200. In Cologne there are ten independent private establishments, besides four sworn brokers, and about twenty-two persons authorised to act as mediators between the people and the public or municipal pawnshop. The business of these private institutions in Cologne is very active, for many prefer to go to private pawnbrokers, perhaps because they lend more money on the articles, or because the business is more expeditiously conducted than in the municipal house. Although they are compelled to keep a record of their transactions the amount of business done by the private brokers is not generally known, as they are obliged to give only authentic information to the police and tax officials. For this reason no statistics as to the exact amount of such business can be given. Under the head of "lombard business" are included loans on securities, mortgages, deeds, precious metals, wares, raw products, &c.; these belong to the active business of banks. The Imperial Bank lends money, to one-half or two-thirds of their value, on raw products, such as grain, spirits of wine, oil, sugar, petroleum, &c., which have been appraised by special inspectors.

MOTOR CARS.

The motor car has been with us for some years, and we are now in a position to form some idea as to its value. It is fortunately no longer considered worth the attention of the unprincipled speculator. Even the sanguine inventor seems to have made up his mind to stand on one side, and to permit the more or less trained engineer to try what he can do with self-propelled vehicles. We have at last some facts to go on; some experience has been acquired, and the merits and demerits of various attempts at the construction of self-propelled vehicles can be gauged with a moderate approach to accuracy. Broadly stated, the results of the expenditure of a great deal of time, skill, money, and energy, are comparatively insignificant on the one hand, and on the other, not full of promise for the future. Self-propelled vehicles are of two kinds, and the difference is strongly marked, namely, the pleasure carriage and the motor van. A qualified success has been achieved with the Daimler light oil or spirit-engine as a motor for various types of the first vehicle. For the second, steam generated by liquid fuel has given so far the best,

if not the only satisfactory result. In this country the manufacture of neither kind of vehicle has attained hitherto to any commercial importance. In France there is, however, a large demand for light carriages; and it is worth notice that dozens of them are always for sale second hand. Whether this is because the owners are dissatisfied with their performance, and want to get rid of them, or are so pleased with what they have already had that they wish for something better, we are unable to say. Probably both motives are at work. It is not too much to state that at least 90 per cent. of the French cars are driven by Daimler or Benz spirit-engines. The legal restrictions on the use of the dangerous benzine and other petroleum "spirits" are much less severe in France than they are with us. This no doubt facilitates their use. But the secret of the popularity of the motor car is to be sought in the fact that the French people do not love horses as we do at this side of the Channel; and that they are permitted to travel at speeds on the highway, and even in the streets, which would not be tolerated for a moment in Great Britain. The principal advantages possessed by a motor-car are, in French eyes, that it is not drawn by a horse, and that it can run much faster than any horse could travel. Lacking the same stimuli in this country very few motor-cars are in use. It is not possible to arrive at accurate figures, but we shall probably be near the mark if we say that there are a couple of hundred machines of the kind running; and, so far as the public are concerned, this lack of appreciation does not appear to be in any way a result of apprehension. It is not the fear of a burst up or a breakdown, but simply that the average Briton does not care for locomotion on the highway other than that which is provided by his own legs or that of a horse. The bicycle is the greatest enemy the pleasure moto rcar has had to contend against.—*The Engineer*.

Obituary.

John Donaldson.—Mr. John Donaldson, who had been a member of the Society of Arts since 1878, died, after a long illness, on the 4th inst., in his fifty-eighth year. For the last 25 years he has been a partner in the well-known firm of J. T. Thornycroft and Company, of Chiswick. The firm originally started as launch builders, but have since, as is well known, attained a high reputation as builders of high-speed torpedo boats, a position due in no small measure to the energy and mechanical ability of Mr. Donaldson. Previous to his joining his brother-in-law, Mr. Thornycroft, in this business, he had held some important engineering appointments in India, where he was chief mechanical engineer at the Dum Dum Arsenal, and afterwards chief assistant to the Calcutta Port Commissioners. Though a member of long standing, Mr. Donaldson never took any active part in the work of the Society.

General Notes.

Fumigation of Trees.—The fumigation of trees for the destruction of insect pests has for some time been extensively used in California and other parts of the United States. The process will probably soon come into use in New South Wales, for Mr. W. J. Allen describes in the *Agricultural Gazette* of the Colony some very successful experiments in spraying and fumigating for red and other scales on orange trees. The tree to be treated, is completely covered with a tent, and is subjected for nearly an hour to the fumes of hydrocyanic acid, produced by the combination of sulphuric acid and potassium cyanide. The number of men generally employed in a fumigating gang is four or five, according to the size of the trees. One man introduces the chemicals, another looks out for the generator and measures the acid, and two or three handle the tents. Such a gang can handle from thirty to forty medium-sized tents, and cover four to six acres of orchard in a night. Fumigation is to be preferred above spraying, because the trees are not in any way damaged by the fumes, except in the case of a few of the tender leaves, while the solution used in the sprays must to a certain extent close the pores of the tree and slightly weaken it.—*Nature*.

Shipbuilding in England.—It is stated that during the month of September English shipbuilders put into the water 29 vessels, aggregating about 93,263 tons gross, against 21 vessels, of about 65,263 tons gross in August, 30 vessels, of about 58,572 tons gross in September last year, and 20 vessels, of about 31,566 tons gross in September, 1897. For the nine months English builders have launched 224 vessels, of about 634,460 tons gross, as compared with 255 vessels, of about 624,108 tons gross, in the corresponding period of last year, and about 448,882 tons gross in 1897. One steamer, of 11,850 tons gross, was launched at Belfast last month. For the year so far there have been launched in the United Kingdom 487 vessels, of about 1,067,143 tons gross, against 535 vessels of about 1,019,908 tons gross, for the first nine months of last year.

Swiss Electric Railway.—The United States Consul at Marseilles reports that the Paris, Lyons, and Mediterranean Railway Company, headquarters at 88, Rue St. Lazare, Paris, has undertaken the construction and operation of an electric railway between Fayet and Chamounix, at the foot of Mont Blanc. The line is to be in operation within twenty months, and it is to be presumed that the company will be interested in propositions for machinery and equipment. Power is to be furnished by the River Arve. The cars are to be automobiles, each supplied with its own dynamo. The contract for building the road proper and providing the water power has been divided into two parts and awarded to Gagner and Frères, of Annecy, and Richard and Meynard, of Avignon.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1900.

The dates fixed for the Examinations in 1900 are Monday, March 26th; Tuesday, 27th; Wednesday, 28th; and Thursday, 29th.

The Programme of Examinations is now ready. Copies of the Programme, with full details, and an Appendix, containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, W.C.

Proceedings of the Society.

CANTOR LECTURES.

THE MANUFACTURE OF LEATHER.

By Prof. Henry R. Procter.

LECTURE IV.—Delivered May 8, 1899.

In the last lecture we discussed the various processes of mineral tannage: it now remains to us to consider those in which organic substances are the tanning agents; and, firstly, those in which oils and fats are the materials employed. Probably, in the primitive forms of rubbing with fat and fatty matters such as brains, these were the very earliest methods invented, but the typical oil dresses of the present, such as chamois and buff leathers, are something very different from their earlier prototypes. Besides these, the action of oils and fats on the skin plays its part in the manufacture of many other sorts of leather, if only in a secondary way; most markedly, perhaps, in the lace and belt leathers known as "Crown" and "Helvetia" leathers, and their congeners, but still distinctly in the mineral leathers in which egg yolk and fat-liquors are used, and even in tanned leathers which undergo the process of currying.

Before I can speak of the theory of oil dressing, the actual process of chamoising must be briefly described. Ordinary wash-leather, which will be the most familiar instance to most readers, is made from the inner split of sheep-skins, often called "sheep linings." The skin, after being deprived of its wool by the fellmonger, is limed for a short time to plump it tolerably, and in this state is split into two thicknesses by a machine which draws the skin over a steel straight-edge against a straight blade to which a rapidly reciprocating motion is given by an eccentric. The grain split, which, curiously enough, is considerably the larger of the two, is used for the manufacture of the thin fancy leathers so often used for bookbinding and portfolio work, while the lining goes for wash-leather. It is first freed from lime by bran drenching, and the loose and fatty layer which exists in the centre of a sheep-skin is removed with a sharp knife on the beam. The skins are then placed in the "stocks" or fulling-mill, which has been already described as used for the softening of dried hides, and pounded till a part of the moisture is evaporated, and the fibrous structure has become somewhat loose and open, sawdust being generally added to facilitate the process. Oil is now added in small quantities, cod liver oil of a crude sort being generally used in this country, though on the Continent, whale oil and other marine oils are frequently substituted. The oil is gradually absorbed by the skins, replacing the water, which evaporates, the skins being occasionally hung up for a short time exposed to the air to facilitate the operation. When the water has been entirely expelled, the skins lose their original limy odour, and acquire a peculiar mustard-like smell due to the oxidation of the oil. They are now somewhat loosely packed in a box, where they heat rapidly from continued oxidation of the oil, and must be taken out and exposed to the air at intervals to prevent overheating and consequent injury, since the oxidation of drying oils take place so rapidly as in many cases to produce spontaneous combustion. During this heating process, much pungent vapour of acrolein is given off, the colour of the skins changes to a pronounced yellow, and the tanning process is complete; but it still remains to rid them of the superfluous oil. In the old English process this is accomplished by washing with warm soda solution, by which the oil is partly saponified and partly emulsified, so that it can be washed out. In France, where the oxidation takes place more gradually, the skins being freely exposed to the air by hanging frequently during the stocking pro-

cess, and the final oxidation being also accomplished by hanging in warm rooms, the oil is much less viscid, and a large portion of it can be removed by dipping the skins in hot water, and then wringing or hydraulic pressing. The oil pressed out in this way constitutes the pure *moellon dégras*, or *première torse*, which, after mixing with tallow and other cheaper fats, constitutes the degras of commerce so much esteemed in currying. The oil obtained in the English way by washing out with soda, and afterwards acidifying the solution, is known as sod oil, and is much less esteemed, but as some English chamoisers now work in a way very little different from the French, and obtain their oil by pressing, it is hard to see why it should not be equal to the French product, if properly used. White wash-leathers are made by bleaching in the sun, the skins being moistened with water and the alkaline fat-liquor obtained in washing out the remaining oil; or the bleaching is accomplished by oxidising agents, such as permanganate, followed by treatment with sulphurous acid to remove the manganese peroxide formed; or by sodium peroxide. Oil leathers are the only ones except chrome leather which will stand the action of hot water, and indeed immersion in hot water is constantly used on buff leather to shrink or "tuck" the leather so as to make it thicker and more compact.

The chemical explanation of the process of chamoising is as yet by no means certain. The oils used are invariably drying or semi-drying oils, and Fahrion has shown that even with linseed oil the effect can be produced, though marine oils are always used in practice. Though the outlines of the chemistry of oils are now pretty well understood, there are yet many details to be filled in. All oils, with the exception of sperm and others of its class, which are chemically liquid waxes, are etherial salts of glycerine and certain organic acids, in which glycerine plays the part of a base. The simplest class of fatty acids are those of the acetic series, in which the CO.OH group, characteristic of all organic acids, is combined with a hydrocarbon group. This is practically a paraffin in which the place of one of the terminal hydrogen atoms is taken by the CO.OH group. I need hardly explain that the carbon atom is tetravalent, or has the power of linking itself to four other atoms, as in the case of marsh gas CH_4, which is the simplest type of a paraffin, and which, when carboxyl is substituted for one of its hydrogens, forms the type acid of the fatty series, acetic acid or vinegar. Now it is possible to replace another H of the CH_3 or methyl group in acetic acid by a second CH_3 group, and so on, building up a chain, plain or branched, in which each carbon, except the end ones, is linked to two H atoms, and two other carbon atoms. Such acids are called "saturated," because all the combining powers of the carbon atoms are fully satisfied, and nothing can be added without displacing something already there. The higher members of this group are hard crystalline fatty bodies, such as stearic and palmitic acids. This is, however, another class of acids, in which, somewhere in the chain, two carbon atoms are linked to each other by a double bond, which replaces two of the hydrogen atoms. The higher members of this class are oily bodies like oleic acid, the glyceride of which is the main constituent of olive oil. When these unsaturated acids are exposed to the action of iodine, bromine, chlorine, or oxygen, the link gets broken open, and additional atoms of the elements named take the place of the hydrogen atoms of the saturated acids. In oleic acid, oxygen is not readily absorbed, and hence its glycerides form excellent lubricating oils, little prone to change by exposure to the air. Other fatty acids exist however, in which two, or three, or possibly even more of the carbon atoms are double linked, and these, under favourable conditions, absorb oxygen greedily from the air, becoming converted into gummy solid bodies. Such oils, as for example linseed, are called drying oils, and are much used as varnishes, and for vehicles for paints, since they harden by exposure to the air, not by evaporation, but by actual conversion into insoluble and solid bodies. All the fish oils contain unsaturated acids such as I have described, and are possessed more or less of drying properties, and some few of them, as for instance menhaden or "porgie" oil, are used for rough painting. The oxidation undergone by such oils is by no means a simple one, and varies in character with the conditions, and in most cases as well as solid bodies, volatile aldehydes, and ketones are produced by the breaking up of the hydrocarbon chain and the direct double linking of the separated fragment with oxygen. The glycerin also becomes dehydrated during the heating process, producing large quantities of the very pungent acrylic aldehyde or acrolein. Knapp supposed that the formation of oil leathers was sufficiently explained by the coating of

the fine fibrils of the skin with the varnish-like and waterproof products of the oxidised oils. No doubt this action does take place, and in many classes of leather is of real importance, but that it does not completely solve the problem is shown by the fact that washleather can be treated with warm alkaline lyes in which these bodies are easily soluble, without losing its character. Cotton impregnated with drying oils and exposed to air, as in the case of oilskins, has its fibres covered and coated as Knapp supposed, but the coating is easily removed by washing with alkalis. I had supposed that the action might be explained by the fatty acid having actually become dissolved in the leather fibre, while in the case of cotton it merely coated the surface, but I am now inclined to look for an explanation in another direction. It has long been known that formaldehyde, the simplest body of the aldehyde class, had the power of rendering gelatinous fibres insoluble even in hot water, and several patents have been taken for its use in tanning. Messrs. Pullman, of Godalming, indeed have recently succeeded in producing by its aid leathers which have all the good qualities of chamois leathers, but in which no oil is used. It appears that this power of hardening gelatinous fibres is a general one of the aldehyde class, and as it has just been stated that considerable quantities of these bodies are among the products of oxidation of many oils, it may well be that the special action of drying oils is not due to the varnish-like coating which they produce on the fibre, but to the direct tanning action of the aldehydes which are formed during their oxidation.

In 1852, a German cabinetmaker named Klemm, who had turned his attention to the manufacture of lace and belting leathers, sold a process to a Mr. Preller, by whom it was patented in England, and the patentee set up works in Southwark, and adopted a crown as a trade mark. The leather was thence named "Crown" leather, but later the term "Helvetia" leather has been more commonly applied in England to leathers of the same type. The material used in the manufacture of Klemm's leather was a mixture of barley meal, ox brains, butter, milk, and soft fat, with a little saltpetre to act as an antiseptic. It is hard to believe that the milk and butter were ever really used in practice, and it was soon found that of the materials named, only the flour and the fats were essential, though ox brains, where they could be obtained, were a useful addition. The process was, in fact, the primitive one of kneading the raw skin with fats and albuminoid substances, and only the gluten of the flour really entered the leather. The hides, unhaired in the usual way, but not specially freed from lime, are coated with a thick layer of the pasty mixture which has been described, and introduced into a large drum or barrel churn, fitted with means by which damp warm air can be circulated through it while in motion through the hollow axles. After some hours drumming, the hides are taken out, slightly dried, and given a second coating of the paste, and so the process is repeated two or three times, when the hides are simply set out and dried ready for use.

Even the flour is not essential for the process, as leather equally tough, but not so full and plump, can be produced with fat alone. Any fat can apparently be used for the process, so long as it is liquid or semi-liquid at the temperature of the drum, and soaps are sometimes added with advantage, as they assist in the emulsification and penetration of the oils. Eitner, who examined many of these leathers, found that if the albuminoid matter of the flour or brains were removed by washing with an alkaline lye, a sort of imperfect buff or chamois leather remained. Probably, little by way of scientific explanation can be added to what has already been said of the action of fats and albuminoids in tanning. As in the case of calf kid, the albuminous matter of the flour is drummed into the skin, and becomes fixed there by the same tawing or tanning action as converts the skin itself into leather.

Klemm invented another sort of lace leather prior to the "Crown" leather, in which the raw hide was first treated with alum and salt, and then washed so as to free it of all which could be removed in this way, after which it was treated with a fat and flour paste in the same way as the "Crown" leather. Excellent leathers, known as "Rawhide," have since been made on the same principle for such purposes as laces and picker bands, where great toughness is required. Their similarity to calf or glove kid, in principle at least, is at once apparent.

I must now enter on the consideration of the vegetable tannages, and perhaps I should first offer an apology for leaving what is still, commercially, by far the most important tanning process to so late a place in the course of lectures. My excuse must be that I have aimed in these lectures rather to deal with the scientific aspects of leather manufacture than its practical side, and that while vegetable tan

ning is one of the most ancient and important branches, it is also one of the most difficult to explain. What explanation can be given must be based on what we have learnt of the simpler processes.

The vegetable tannins form a large class of bodies varying very considerably in their chemical structure, but having in common the properties of precipitating gelatine from its solution, of forming dark-coloured compounds with ferric salts, and converting skin into leather. The function of the tannins in plant life is not very clear. They are widely distributed through almost all classes of flowering plants, and occur at times in almost all parts of the plant, but perhaps most abundantly in fruits and barks. They are also very frequent in galls caused by the attack of insects and aphides, though they are sometimes credited with being deterrents of insects. A curious point is that even in the same plant different tannins may exist in different parts; thus the tannin of the bark, the wood, the acorns, and the galls of the oak is distinctly different, though it is quite possible that all of them are mixtures; since, from their uncrystallisable character, any very accurate separation of the different tannins has so far proved impossible, and it is by no means certain that the number of really distinct tannins is a large one.

Beside the chemical reactions which I have stated to be common to the whole class of tannins, there are certain relations in chemical structure which must be briefly mentioned. All tannins belong to the great class of "aromatic compounds," which also includes most of the coal-tar colours, and many of the most important products of manufacturing organic chemistry. The peculiarity of this class is that all the bodies belonging to it contain a group of six carbon atoms, usually supposed to be linked together in a ring form, which remains unbroken through all the combinations into which it enters. The simplest of these compounds is ordinary coal-tar benzene, a colourless volatile liquid, the molecules of which consist merely of the six-carbon ring combined with six atoms of hydrogen. Closely allied to this is phenol or pure "carbolic acid," which differs only from benzene in having an —O – H group substituted for one of the hydrogens. Other phenols exist containing two —O—H groups replacing hydrogen (dihydric phenols), and three —O—H groups (trihydric phenols). If we represent the benzene ring, as is usual, by a hexagon, of which the angles correspond to the carbon atoms, it is obvious that so soon as we have more than one substituted hydrogen there will be a possibility of different compounds identical in the number and kind of their atoms, but varying as the substituted groups occupy respectively the 1—2, 1—3, 1—4 positions, and so on. Such bodies actually exist, and are known as "isomeric." Thus there are, as might be predicted, three different dihydric, and three trihydric phenols. From each of these bodies organic acids may be derived by substituting the CO.OH group for yet another of the hydrogens. All the natural tannins contain either the dihydric phenol, catechol, or its corresponding acid, protocatechuic acid; or the trihydric phenol, pyrogallol, or its corresponding acid, gallic acid. No natural tannins seem to be formed from any of the isomeric members of the phenol class, though some, in addition to catechol, contain the trihydric phenol phloroglucol; but it is stated that bodies having many of the properties of tannins have been artificially formed from other phenols.

The tannins therefore fall naturally into two great classes—those derived from protocatechuic acid, and which yield catechol on dry distillation, and which may therefore be called the catechol tannins, and those from gallic acid, which yield pyrogallol on heating, and may similarly be called the pyrogallol tannins. It is possible, though not certain, that tannins may exist which contain both these groups at once, and it is certain that there are catecholphloroglucol tannins, containing both the dihydric phenol catechol, and the trihydric phenol, phloroglucol. This difference in constitution corresponds to a marked difference in properties. The catechol tannins generally give green-blacks with ferric salts (though infusions of some of the mimosas give violet-blacks, probably from the presence of colouring matters). Their infusions are precipitated by excess of bromine water, and, employed in tanning, or boiled with acids, or even alone, they give dark-coloured, and generally red and difficultly soluble products, which are deposited on the leather, as in the characteristic case of the hemlock bark of America. Similar red products of oxidation or dehydration are produced by exposure to the sun, so that pale leathers from these tannins, such as East Indian sheep and goat skins, tanned with "turwar" bark (*cassia auriculata*), are rapidly darkened by light, and may even be printed under a photographic negative. The catechol-phloroglucol tannins, such as those of cutch and gambier, behave in this respect very similarly to the

ordinary catechol tannins. Pyrogallol tannins, on the other hand, give blue-blacks with ferric salts, and no precipitate with bromine water, and usually a pale precipitate of ellagic acid with acids, and on the surface of leather, constituting what the tanners term "bloom." This deposit is not due to the decomposition of gallotannic acid, the "pure tannin" of the shops, and the most important of the pyrogallol tannins, but to the presence in larger or smaller proportion of an allied tannin, ellagitannic acid, of which the constitution is very imperfectly understood. Gallotannic acid itself gives no "bloom," though ellagic acid is easily formed from it by the action of dehydrating agents. Divi-divi, myrobalans, sumach, and galls are good instances of pyrogallol tanning materials, the proportion of ellagitannic acid present being largest in the first and smallest in the last. The only tannin of which the structure is approximately understood is gallotannic acid, which was proved by Schiff to be a digallic acid, or acid anhydride of gallic acid; but even in this case it has been lately shown that Schiff's synthetic digallic acid is not absolutely identical with the natural product.

The precipitate which is formed when gelatine and tannin solutions are mixed is not of constant composition, but varies considerably, according to whether the gelatine or the tannin have been in excess at the moment of combination. Its composition is also altered by washing with hot water, so that it has not the characteristics of a definite chemical compound, but suggests rather the result of a chemical equilibrium, such as has been described in connection with the pickling process, though no explanation on these lines has yet been attempted. It is possible that there may be more than one compound formed between gelatine and the tannins, and that the observed irregularities of composition are due to the presence of the two compounds in varying proportions.

The popular idea that modern tanning is done with "chemicals" as opposed to vegetable tanning materials is altogether erroneous. The great changes which have taken place in tanning methods since the days of our forefathers have been in the first instance mechanical; much work which was formerly done by hand is now accomplished by steam-power. In the second place, advantage has been taken of the vegetable products of other lands, often cheaper and richer in tanning matter than our indigenous oak bark, and, therefore, enabling leather to be more quickly produced by the use of stronger infusions, and still more by their systematic change and renewal. The best leathers of the present are probably not only cheaper, but actually better than those of earlier date, and I do not believe that those who are willing to pay a reasonable price for a good material were ever better shod than at present; though it must be admitted, on the other hand, that at a low enough price worse rubbish can be obtained than our forefathers knew how to make, and that, at the same time, it is so well got up that no one but an expert can judge by its appearance.

In older times, oak bark was practically the only tanning material used in England, and its great virtue was that leathers made with it alone were applicable to a great variety of purposes, and that with an honest tannage it was hardly possible to produce other than a fair wearing quality of leather. Among the host of materials now at the disposal of the tanner, there is scarcely one with the same wide range of applicability, and, therefore, much more skill is required in their proper use and combination, while some of them lend themselves readily to the production of qualities, such as weight and colour, which are profitable to the tanner, while offering no guarantee of wear to the purchaser. One of the most important of modern materials, though now in its turn somewhat eclipsed by later introductions, is valonia, the large acorn

FIG. 15.

THE VALONIA OAK (*Quercus ægilops*).

of an evergreen oak of Asia Minor and Greece, which contains about three times as much

tannin as the strongest oak bark, but of a somewhat different character, giving a harder and heavier leather owing to the presence of a larger proportion of ellagitannic acid, which yields much of the white deposit known as "bloom." Another exotic material of somewhat the same character, but yielding a rather lighter and more porous leather, is myrobalans, the dried fruit of a large Indian tree, *Terminalia chebula*. Akin to this in the character of its tannin, but yielding still lighter coloured, softer, and lighter-weighing leather is the sumach, the leaf of the *Rhus coriaria*, of Sicily, which is used mainly for soft and light leathers such as morocco, in which resistance to water is of small importance. The tannin of sumach is nearly pure gallotannic acid, allied with a colouring matter giving yellow dyes with alum and tin mordants, and which has been shown by Perkin to have interesting chemical relations to the tannin with which it is associated. I must also mention *divi-divi* and *algarobilla*, the pods of South American trees closely allied to logwood, which are amongst the richest of natural tanning materials, *algarobilla* being perhaps six times as strong as oak bark. The curious name, *divi-divi*, has a legendary connection with David Davis, who is said to have been the captain of the ship in which it was first imported, but the history of the word *algarobilla* is somewhat more interesting. The Arabic name, *al kharrouba* (the locust bean), was introduced into Spain by the Moors, and under the Spanish form *algaroba* is the general name in Spanish-speaking countries for a bean-like pod, of which *algarobilla* is of course the diminutive. All these materials contain tannins, mainly of the pyrogallol group, and to them one more may be added, which is of constantly increasing importance. The wood of the oak, like most other parts of the tree, contains tannin, yet in very small proportion, say only one-fourth as much as in a good oak bark. It is therefore, in itself, a practically valueless tanning material, but one to be had in enormous quantities, especially in the great oak-forest districts of Slavonia, as a waste product from the timber industry. It is, therefore, converted into an extract of at least ten times the tanning strength of the original material. The timber is first reduced to shavings about one-eighth of an inch thick by the action of a machine, of which the essential part is a drum fitted with powerful plane blades on its circumference, against which the timber is pressed. The shavings are carried by elevators and chain-conveyers to a series of large vats fitted with steampipes for heating, and by pumping from one to another of these, tolerably strong liquors are obtained, but of a colour too dark to meet the somewhat exacting require-

FIG. 16.

OAKWOOD EXTRACTION IN SLAVONIA.

ments of the tanner and his customers, both of whom are ready to sacrifice a good deal of real quality and cheapness to the appearance of boot soles which the first day's wear will irretrievably disfigure! The liquors, therefore, after settling and cooling to a temperature of about blood heat, are treated on precisely the same principle as the cook uses to brighten her jellies, but in the place of white of egg the cheaper substitute of dried blood or blood-albumen is employed. This is dissolved in water and well mixed with the liquor by revolving stirrers, and the temperature is then raised till the albumen coagulates and carries down with it a good deal of the colour and suspended impurities, together with a certain portion of the tannin. The liquor is now settled, and the muddy portion filter-pressed; the clear infusion thus obtained is run to vacuum pans and concentrated, at a low temperature, to an extract of about the consistency of treacle, and containing about 25 to 30 per cent. of tanning matter. Another kindred industry is the manufacture of extract from the wood of the Spanish chestnut, principally carried on in the South of France where this tree is abundant. The chestnut contains more tannin than oak wood, and the manufacture of the extract is carried on in a similar manner. The product differs but little from oak wood in its tanning properties, and is so like it in appearance and chemical characteristics that it is frequently substituted by unscrupulous dealers.

So far, I have spoken only of tannins belonging more or less definitely to the pyrogallol group. I must now mention some of the derivatives of catechol. Of indigenous European representatives of this class the barks of the larch and the spruce fir are the most important representatives, larch bark being used in Scotland for tanning sheepskins, while spruce bark is one of the most important materials in eastern Germany and Austria. Curiously, spruce bark is not used in Scotland, and larch bark but little on the Continent, while what becomes of the enormous quantities of spruce bark which must be produced in the Scandinavian forests I have never been able to discover. Both barks make leather of a pale colour, and, for many purposes, of excellent quality.

Of much greater importance than the European pine barks is that of the American hemlock spruce (*Tsuga* or *Abies Canadensis*), which is one of the principal tanning materials of North America, and which is used not only for the red hemlock sole leather, but either alone or in combination with other tans or with alum, for a large proportion of the dressing leather which is exported to Europe. Another tannin of the group which, in the form of extract under various names, is gradually finding its way into English yards, is from the bark of various trees of the mangrove family, and especially from *Ceriops Candolleana*, which is very abundant in the swampy creeks of tropical Africa and the East Indies. Quebracho, the very hard and heavy wood of a tree from the Argentine, belongs to the same class of tannins; and canaigre, the tuberous root of a large dock, is also a catechol tannin, though different in many respects from those already noted. The various mimosas and acacias also belong to the catechol group.

The modern tanning process consists in submitting the hides or skins, previously prepared by the methods of liming and bating which have been already described, to infusions of tanning materials, which are gradually increased in concentration as the process advances, and of which the strength is frequently maintained in the later stages by layers of the ground tanning material dusted in between the leather. In earlier days, this dusting was the principal means of bringing the tanning matter in contact with the skins; and much of the increased rapidity of modern processes is due to the use of strong infusions which keep up a better supply of the tannin. The making of such strong liquors without wasteful expenditure of the material is therefore an important branch of the tanners' art. Much of the success of the operation depends on the suitable pulverisation of the material in the first instance. The tannins are formed in cells with cellulose or woody walls, through which, from their uncrystallisable character, they diffuse very slowly, and it is therefore important that the cells should be as much broken up as possible in grinding and crushing. On the other hand, in dealing with large quantities, it is found that too finely powdered material, when it is wet, presses together into a mass so solid that the liquor will not percolate through it, and it is necessary that it should be sufficiently coarse, or in such a condition that this does not take place. The best way of accomplishing this is dependent on the nature of the particular material. With woods, it is found that shavings cut transversely to the grain, so as to divide the sap tubes into short lengths, are very satisfactory; barks are best ground in such a way as to rag them as completely

as possible without the production of too much fine dust; while many fruits, such as myrobalans and valonia, are better crushed into flakes rather than actually ground. The extraction takes place in large vats or leaches, provided with a latticed or perforated "false bottom," to allow of drainage; and in the best yards these are generally connected in series of 6-10 vats in such a way that the liquor from the bottom of the weakest and nearly exhausted vat flows by gravitation on to the top of the next stronger, forcing its liquor down through the false bottom and up a tube on to the top of the next, and so on. This method greatly diminishes the labour of pumping, and makes it possible to secure a much more constant and systematic change of liquor, which is of great importance, since the dissolved tannin in the material will only diffuse out into liquor weaker than itself, and no length of mere soaking in liquors which are not sufficiently changed will accomplish satisfactory exhaustion. The use of heat is also of great service. Hot liquors not merely extract more rapidly, but bring portions of the tannin into solution, which cannot be extracted in the cold. On the other hand, the colour of these "difficultly soluble tannins" is generally darker and redder than that of the more soluble part, so that in many cases it is a question of judgment how much tannin it is worth to sacrifice for the sake of improved colour. It has been shown by the work of Parker, myself, and others that each tanning material has an *optimum* temperature of extraction, at which more tannin can be removed than at any other, but this is sometimes too high for the best results in colour. As a general rule, however, considerably increased quantities of tannin can be extracted by the use of heat, say, up to 60° C., on the weaker and nearly exhausted leaches, without any commensurate injury to colour.

The hides for sole-leather are generally brought into the liquors without bating, and still swollen with lime. In this case it is of essential importance that the first weak liquors in which they are "coloured" should contain a sufficiency of weak vegetable acids, such as lactic and acetic, to neutralise and remove the lime, which will otherwise combine in an insoluble form with the tannin in the surface of the hides, forming easily oxidisable compounds which darken seriously on drying, and frequently make the grain of the leather brittle. If previously to bringing the hides into liquor any portion of the lime has been allowed to become carbonated by exposure to air, or to "temporary-hard" water, this is much less soluble in the very dilute weak acids present, and so is almost certain to result in dark stains and brittle leather. In modern yards the hides are generally suspended in the liquor, so as to expose their surfaces freely to its action, and they are frequently kept in gentle motion by some mechanical device, while the liquor is circulated by a system of tubes and troughs, similar in principle to that used in the leaches, but in the reverse direction.

Where sole-leather hides have been unhaired by "sweating" or by the use of concentrated solutions of sulphide of sodium, which does not sufficiently swell and split up the fibre bundles, it is absolutely essential for the production of satisfactory sole-leather that the liquors should be acid enough gradually to plump the fibre. The natural acids in the liquors are produced, not from the tannins, but by the fermentation of sugary matters present in the barks; and in the older methods where weaker liquors were used, and the time of tanning was proportionately longer, their quantity was often sufficient to produce all the swelling effect required. Now, with more rapid processes, and the use of extracts and other materials which do not readily yield acids by fermentation, this is rarely the case; and hence attempts to tan sweated hides in English tanyards, without knowing the conditions essential to success, have generally proved abortive. In America the difficulty is got over by the use of sulphuric acid; but this is never added to the liquors, both because it precipitates the tannin, and because, perhaps partly on that account, its use produces dark and brittle leather, not unlike that due to imperfect removal of the lime. To avoid this, the sweated hides are first coloured and slightly tanned on the surface in weak sweet liquors, and are then suspended in water to which the requisite small quantity of sulphuric acid has been added. The slight tanning protects the colour of the grain, as on tanned leather sulphuric acid is practically without action, but below the tanned surface a dark layer may generally be detected, caused by the action of the acid. Even the natural and comparatively weak acids of the liquors are capable of producing discolouration and brittleness if they are present in excess. After the hides have been coloured in suspenders, they are laid flat in pits; first, with liquors of constantly increasing strength, in which they are moved, and the liquor changed every day or every other day

("handlers"). After some weeks of this treatment, and when the tannage has pretty completely penetrated the leather, it is placed in pits with stronger liquors, and with valonia or other tanning material dusted between the hides ("layers"). In these pits it is allowed to lie for longer periods, beginning with a week or ten days at the least, and increasing to a month or six weeks, but, of course, details of this sort vary much in different yards, and according to the nature of the tanning material employed. The leather is now washed free from loose bark, &c., partially dried, and finished by rolling and other mechanical processes designed to render it solid and smooth.

The tannage of dressing leather differs but little in principle from that of sole leather, but the hides or skins are freed from lime by bating, or puering and drenching, which, at the same time, reduces the swelling of the fibres, and the skin gains in surface area while it loses in thickness. In this condition the surface is tanned and fixed by the first weak liquors. As the tannage proceeds the skin possibly swells somewhat by the acids of the liquors, and its inner fibrous structure is contracted by the astringent action of the tannins, with the result that its area is again reduced, and the outer grain surface, which was first tanned, is drawn into fine wrinkles or "grain," such as we are familiar with on many soft leathers. This effect is the greater, the stronger the liquors with which the leather is first treated, and the more extended and softer the condition in which it was introduced into them, and it is also favoured by motion in the liquors. If the liquor is too strong, or the colouring or "graining" is carelessly done, the wrinkling becomes coarse and irregular, and we have the defects known to the tanner as "drawn" or "old" grain. If too strong liquors are used at first, or if the hides are carelessly creased, similar defects may occur even on leather which has not been bated, as, for instance, on sole-leather. Where grain is desired, as in moroccos and levants, the colouring is generally effected in a paddle vat, but in some cases where perfectly smooth leathers are required, as in coloured calf, it is best done in suspension, as in the case of sole-leather. The subsequent tannage is similar to that of sole-leather, except that weaker liquors are used, and frequently different tanning materials are selected; the entire process is shorter in proportion to the thinner character of the skin, and dusting material is used less freely, or not at all.

It will be noticed that the whole process of tanning is one of diffusion, which from the colloid character of both skin and tannin is necessarily slow. Many attempts have been made to force the tanning liquors into and through the hides by mechanical means, and tannage can be much quickened by treating the goods in a drum, in which they are continuously tumbled about. In this case, not merely is fresh liquor constantly presented to the hides, but they are continually doubled and squeezed and relaxed, so that the liquor is, as it were, pumped through the spaces between the fibres, but is not materially assisted in its penetration of the fibres themselves, so that leathers produced in this way tend to be rapidly and evenly tanned through, but without very complete tannage of the interior of the fibres themselves, which, for certain purposes, is advantageous, while for others it is not. Leathers tanned in this way are likely to be tough rather than solid; and it is doubtful whether the very best class of sole-leather can ever be produced by the quick processes. Lieing "dusted down" with solid materials for long periods, as in the ordinary sole-leather process, produces a sort of solidity which cannot be got by liquors alone; since the liquors contain mostly the easily soluble tannins, while in the dusting down process, the less soluble also dissolve in small quantity, and are eagerly absorbed by the hide, while the liquor dissolves further quantities from the tanning materials, and in this way these bodies, which contribute greatly to the solidity of sole-leathers of the old sort, are gradually transferred to the leather. To a certain extent the same effect is produced by the use of warm liquors in drumming, as by the aid of heat many of these bodies are rendered much more soluble.

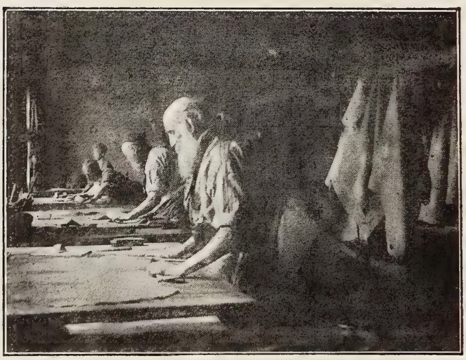
Several processes of "electric" tanning have been patented, but as yet no very convincing proof has been given of their commercial success. There is no doubt that the passage of an electric current increases diffusion through membranes, and at the same time warms the liquor, and both of these effects should tend to quicken tanning, while, so far as is known, the tannins are not electrolytes, and are therefore not directly destroyed by the current. On the other hand, currents cannot pass without the decomposition of water and the salts it contains; and in many cases the products of these decompositions act destructively on the tannins. It may probably be taken as proved in practice that the

passage of a current quickens tanning; but wherever accurate experiments have been made, there is an apparent consumption of tanning material in excess of that actually absorbed by the skin.

The limited time at my disposal does not allow of any detailed consideration of the processes of currying and finishing which all tanned leathers must undergo before they are ready for the market; and I pass them over the more readily because, though important to the technologist, their interest is mechanical rather than scientific.

The finishing of sole leather aims simply at producing a smooth and even-coloured surface, and a compact and solid material; and is limited to scouring and compressing the surface with stones, brushes, and an implement called a "striking pin," and then submitting to heavy pressure under a brass roller. All these operations are now generally effected by machines.

Fig. 17.

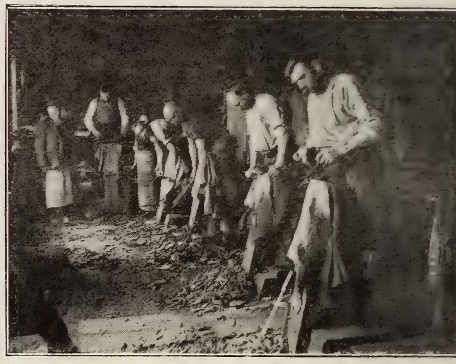


Scouring.

The softer leathers (dressing leathers) which are used for the upper parts of boots and many other purposes, have not only to undergo mechanical treatment for the purpose of smoothing and stretching, but must be "stuffed" or saturated with oils and fats to increase their resistance to water, and to add to their flexibility, and are frequently dyed or stained in black or colours, and submitted to mechanical processes to produce various forms of grain surface. The first operation in almost all cases is "scouring," which is done by machine, or by hand on a flat table, as shown in Fig. 17. The thickness must now in many cases be reduced or rendered uniform by "shaving" with a two-handled knife with a peculiar turned edge, an operation which is shown in Fig. 18. This is frequently accomplished by an ingenious machine of American origin, with a drum with spiral blades kept sharp by an emery wheel. The operation of "splitting" now often takes the place of shaving, especially on the heavier leathers, the hide being separated into two or more thicknesses by a long, keen blade, which is sometimes fixed, but is now more frequently a thin belt of steel, running at a great speed through guides above a solid roller, the distance of which regulates the thickness of the split.

"Hand-stuffing" is accomplished by covering the leather, which must be in a partially wet condition, with a thick layer of "dubbing," which is essentially a mixture of tallow and oils. A crude cod-liver oil is mostly used by English curriers, but other materials, and especially sod-oil and degras from the chamois leather industry, are frequently added. The leather is now hung up in a moderately warm room and allowed to dry very slowly, when the

Fig. 18.



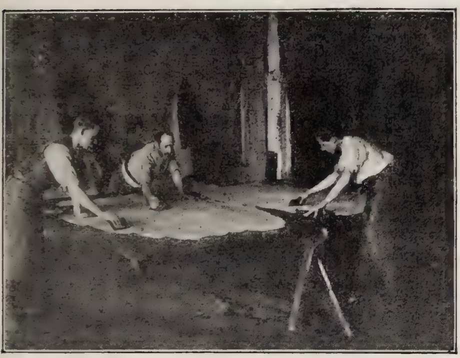
Shaving

oils gradually take the place of the water, which escapes by evaporation, and coat and lubricate the fibres, while at the same time, in lightly tanned leathers, a sort of imperfect retannage or chamoising probably takes place. It is for this reason no doubt that semi-drying oils are generally employed in currying, though recently both mineral hydrocarbon oils and animal non-drying oils have been used with success.

In the process of hand-stuffing, it is obvious that only oils and fats, liquid or semi-liquid, at the temperature of the drying-room, can be absorbed by the leather, the tallow of the dubbing being mainly useful to retain the oils on the leather, and being largely left on the surface when the drying is complete. This difficulty is obviated by the method of

"drum-stuffing," which has revolutionised many branches of the currying industry. For this process, a drum is used like an enormous barrel churn, and provided with means by

FIG. 19.



PREPARING FOR JAPANNING.

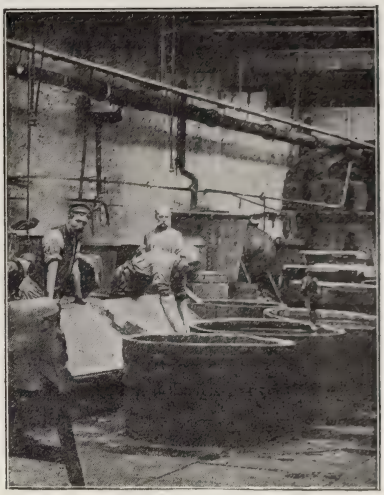
which it can be heated by steam to the temperature of melting fat. The leather in a suitably damped condition is introduced into the hot drum, which is closed and set in rotation, and the melted fats, which in this case may be of tolerable high melting point, are introduced through a hollow axle of the drum, and in less than half an hour are completely absorbed by the leather. In some American leather works a weight of solid greases exceeding that of the dry leather is thus introduced.

FIG. 20.

SCOURING MOROCCO SEALS.

The subsequent processes of finishing vary too much with different kinds of leather to be dealt with here. A word or two, however, may not be out of place with regard to "patent" and enamelled leathers, which are not without chemical interest. The varnished surface of these leathers is produced by a "japan" of which the essential constituents are linseed oil and Prussian blue, boiled

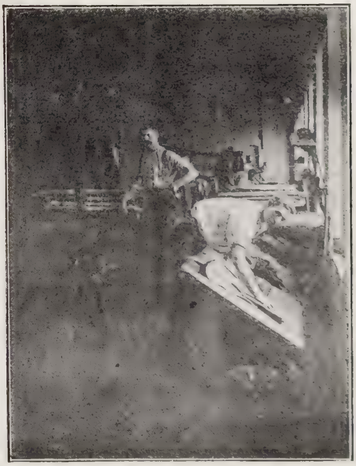
FIG. 21.



MOROCCO DYEHOUSE.

together to a viscous mass. The japan is not blue, but brownish black, and it is possible that the Prussian blue is broken up by the heat, and that the iron oxide serves as a

FIG. 22.



MOROCCO FINISHING SHOP.

"drier," as well as to produce a black compound with the linseed oil; and it is worth the study of manufacturers whether a cheaper compound of iron might not be found to answer

the same purpose, and, in fact, the whole question of the preparation of the japan would well repay investigation. The leather which is to be japanned is stretched on large boards, as shown in Fig. 19, which are fitted to slide like drawers into drying chambers heated to 140°-160° Fahr. The japan is applied with a sort of toothed steel plate, and after the coating is dry, it is smoothed down with pumice before a second coat is applied. Frequently seven or more coatings are given, the final one being mixed with copal varnish to produce a more glossy surface.

Moroccos, and coloured leathers are not usually stuffed, though a good deal of oil is often used in the finishing processes. Fig. 20 shows the scouring of sealskins for black morocco or for enamelling; while Fig. 21 represents a morocco dyehouse. The sealskin which is used for these purposes is not that of the fur seal, but the coarser skins of several species common in the Arctic regions.

Miscellaneous.

THE GERMAN BEER INDUSTRY.

The German beer industry has grown year by year, and the increasing capacity of the establishments has made it necessary for the brewers to search for new markets where their overproduction could be disposed of. In the year 1885, the export of German beer reached its maximum, amounting in that year to 1,318,000 hectolitres (28,996,000 gallons), representing a value of 24,000,000 marks (£1,200,000). The next year, however, showed a decrease, and since then the export has gone down to about one-half of what it was in 1885. According to the United States Consul at Kehl, the reason given for this decline is that the countries which were Germany's best customers—France, Belgium, and the Netherlands—have increased their output sufficiently to nearly meet the home demand. The high duty placed on foreign beers by France has also had the effect of considerably reducing the import of German beers into that country. In all those years the export of German beer in bulk (barrels) has been greater, contrary to general belief, than in bottles. German beer once had nearly a monopoly of the beer trade of South America, but there also, it is stated, the demand has decreased, while at the same time, according to trade reports, the demand for the United States has increased. The decline of the German beer trade in Brazil alone, during the year 1896 and 1897, is given as amounting to fully three-fourths of what the German brewers had exported to that country in former years. It is a noticeable fact that while the export has declined year by year, the production of beer in Germany has advanced steadily, showing that the home consumption has greatly increased. At present, the United States is the best foreign customer for German beer, importing in 1895, 522,138 gallons; and in 1896, 689,456 gallons. The export of beer from Germany to Venezuela, Japan, and China together, did not in the years given amount to one-half the exports to the United States alone. Brazil and British India, as consumers of German beer, come next to the United States. The German brewing industry has strong hopes of entirely supplanting the English in Australia and other British colonies.

Obituary.

VICE-ADMIRAL PHILIP HOWARD COLOMB.—Admiral Colomb died suddenly on Friday night, 14th inst. He was elected a member of the Society of Arts in 1873; he took much interest in its work, and was a frequent attendant at its meetings when subjects in which he was interested were discussed. The last paper which he read before the Society, was on February 20, 1895, on "The Rule of the Road at Sea." Colomb began to study the question of signalling at sea at night, both experimentally and practically, in 1858. His invention of the flashing lantern was completed in 1861, but it was not finally adopted in the Navy until 1867, and by that time the principle of his invention had been extended so as to apply to signals by day as well as signals by night. On March 12th, 1873, Captain Colomb read a paper on "Signalling at Sea with especial reference to signals of distress." On November 29th, 1882, he read a paper on "Some of the Causes of Collision at Sea," which attracted so much attention that an additional evening was devoted to the adjourned discussion. Colomb was born in May, 1831, and he entered the navy in 1846. He attained the rank of Vice-Admiral on the retired list in 1892. An appreciative record in *The Times* of Admiral Colomb's life-work concludes with an expression of the opinion that his true reward "was the gradual but ever-widening acceptance of those views of naval policy which he held and showed to be vital to his country's security and prosperity, and to the maintenance of her Imperial position."

THOMAS HENRY LORD FARRER.—Lord Farrer, who died on the 11th inst. at his residence, Abinger-hall, Dorking, was elected a member of the Society of Arts in 1882. He was born in 1819 and educated at Eton and at Balliol, Oxford. After he was called to the Bar he joined the Board of Trade and was for a time Assistant-Secretary, Marine Department, and he afterwards became Permanent Secretary to the Board, from which post he retired in 1886. He was made a baronet in 1883, and in 1893 he was created Baron Farrer of Abinger.

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FRIDAY, OCTOBER 27, 1899.

All communications for the Society should be addressed to the Secretary, John street, Adelphi, London, W.C.

Notices.

INDIAN SECTION COMMITTEE.

A meeting of the Committee was held on Tuesday afternoon, 17th inst. Present: Sir Steuart Colvin Bayley, K.C.S.I., C.I.E. (Chairman), Sir George Birdwood, K.C.I.E., C.S.I., H. M. Birdwood, C.S.I., LL.D., F. C. Danvers, Colonel Sir T. Hungerford Holdich, R.E., K.C.I.E., Sir W. Lee-Warner, K.C.S.I., Sir Roper Lethbridge, K.C.I.E., Sir James Broadwood Lyall, G.C.I.E., K.C.S.I., Edmund Neel, C.I.E., Sir George Scott-Robertson, K.C.S.I., Sir John Scott, K.C.M.G., Sir Charles C. Stevens, K.C.S.I., T. H. Thornton, C.S.I., D.C.L., W. Martin Wood, with Sir Henry Trueman Wood, Secretary of the Society, and S. Digby, Secretary of the Committee.

The arrangements for the Session were considered.

Miscellaneous.

*THE CIVIL ADMINISTRATION OF BRITISH INDIA.**

The subject for our consideration this evening is so wide, and suggests so many different methods of treatment, that the task of dealing with it in any adequate manner within the limits of a single paper is somewhat perplexing. Clearly we must be content to leave untouched many matters connected with the Civil Administration of India; and perhaps our safest plan will be to restrict our view to some of its more striking phases only. In his introduction to Vol. I. of "The British Empire Series," which relates mainly to India, its people, its industries, and its literature, Sir Raymond West puts the case for British rule in India concisely by describing it as "specially distinguished from all previous Governments by the inestimable blessings it has conferred in security, justice, and material development." The description does not embrace the whole field of our Civil Administration, but it covers a great deal of the ground. Let us take it as a text and illustrate it by adducing some relevant facts.

In reference to the fact that the people of India are now protected from violent disturbances of the public peace, and are safe in the enjoyment of personal rights to an extent never realised under any native dynasty, Sir Raymond West tells us, in picturesque language, which I am tempted to quote, that "the lawless hordes who, as armies or as dacoits, once ravaged India almost from end to end, have been suppressed. The peaceful husbandman has no longer to keep his spear and buckler within reach while guiding his plough or reaping his crop. The vigilant watchman on a tower or tree, prepared to give warning of the distant shimmer of lances, is no more needed. The village walls with bastions and embrasures have become an anachronism to a generation whose grandfathers cowered behind them for shelter against Rohillas and Pindáris." The picture is not over-drawn; and an Indian poet, Syed Husain Bilgrami, in an invocation to England, has finely said:—

"England! 'tis meetest that, for weal or woe,
In calm or storm, our chosen place should be
Where honour calls us by the side of thee.
Thy friend be friend to us, our bitt'rest foe
The trait'rous knave who schemes thy over-throw;
For, like to Israel in captivity,
We once were thralls, till thou did'st set us free
And give us peace unknown from long ago.

Aye, peace unknown! when we were sore bestead,
And grievous were the burdens that we bore;
But now, if peace there be, and rest divine,
Good-will 'tween men, and peace, and all that's bred
Thereof, when lawless might is feared no more,
To thee we owe them all, these gifts are thine."

Lawlessness cannot be repressed by gentle means, and the measures by which the enemies of peace have been fought, whether within our borders or on our borders, are matters of history. But even now, when the *Pax Britannica* has been established throughout India, it would be folly to forget that the presence of an effective force of British and Indian troops is still essential to the orderly working of our system of civil administration. It is right, however, to add, and as a nation we may be proud of the fact, that the occasions are rare indeed when it becomes necessary for the civil power to seek military aid for the maintenance of the public peace. And yet an Indian army of twice its present strength would not suffice for the preservation of order if the people themselves were dissatisfied, instead of being well satisfied with the substantial advantages of our rule, as secured for them by the combined efforts of our civil establishments in various departments of the State, and by our courts of civil and criminal justice. They have learned, indeed, to know that our institutions are the outcome of a genuine resolve to maintain an efficient administration for the purposes of righteous government,

* Notes of a lecture by H. M. Birdwood, C.S.I., LL.D., M.A. (late Member of Council, Bombay), given at the Greater Britain Exhibition, on the 29th July, 1899. The chair was taken by Colonel M. McNeill Rind.

according to British standards, in co-operation, "so far as may be," with themselves, as promised in Her Majesty's gracious proclamation of 1858, and that, in giving effect to this resolve, we have acted, in the main, in a spirit of fairness and justice.

We are sometimes described as unsympathetic rulers. So far as I can judge, from my own experience, the people at large do not so regard us, but are accustomed to look upon English officers in the rural districts as their truest friends, who know their wants, listen patiently to their grievances, and give redress impartially. Such an attitude on the part of district officers towards the peasantry is in accordance with the best traditions of the public service, and there is no ground for supposing that these traditions have been weakened of late years. On the contrary, there is ample evidence to warrant the assertion that, in no previous century of the history of India, has more practical sympathy been shown by the rulers for the dumb millions than in the century now coming to a close.

The peasantry certainly know what oppression means, and what good government means; and they are true, as a body, to their law-abiding instincts, not because they are apathetic and do not care whether they are badly off or not, but, whether they love us or not, because they are shrewd and know well that, under a settled Government, with its carefully revised assessments of land revenue, its regular administration of justice, the protection it affords to life and property, its energy in improving and extending means of communication and of water supply, its encouragement of new industries, its care for the public health, its readiness to confer larger municipal privileges and rights of local self-government, wherever evidence is given of capacity for extended powers, they enjoy a measure of freedom and personal prosperity to which their ancestors were utter strangers.

The dwellers in towns and cities also realise that, under the broad ægis of Britain, they are prospering and can exercise their civic privileges and attend to their private affairs in safety. In such a city, for instance, as Bombay, which has been afflicted with sore troubles during the past three years, abounding evidence may still be found of material prosperity.

The plans and aspirations of that wise statesman, Sir Bartle Frere, who acquired, in the ranks of the Indian Civil Service, the wide experience and the knowledge of the people which so eminently fitted him for the various high offices he held in India, have now been largely realised. The magnificent public buildings on the Esplanade were the first-fruits of his labours; and now, for years, the merchant princes, the great mill-owners, the successful members of learned professions, who have accumulated wealth under our rule, have shown that they are no longer content with the dingy dwellings in the native town in which they spent their youth, and are building substantial stone houses for themselves on such noble sites as Malabar Hill, Cumballa Hill, and Mahalaxmi; while, as regards the native town itself, proposals for the better housing of the poorer classes and the completion of other important measures connected with public sanitation, have, for some time, been engaging the earnest attention of the responsible authorities.

Any general proposition that is true of the state of the people of the Bombay Presidency may be assumed to be true, generally, for the whole of India; for the officers who control the whole administration, and those who are employed in the collection revenue and the administration of justice, are recruited—for all provinces—from the same classes, and have similar qualifications and similar training and supervision. I can, of my own knowledge, speak with confidence of the good work done in the Bombay Presidency, and the satisfactory results produced, as regards the general appreciation of British rule, in spite of occasional manifestations of a different estimate of its advantages. I am persuaded that similar results have been produced generally throughout India.

It would be strange, indeed, if carefully devised schemes for the recruitment of the public service, modified from time to time, as the need arose or seemed to arise, were to fail in their object. How carefully we have sought the best available material a little consideration will show. Leaving out of account the clerical and ministerial staff employed in all courts and offices, the members of which are generally appointed by the heads of offices, we find that the judicial and revenue departments, to which we must mainly direct our attention this evening, are controlled and administered by an Imperial Service recruited in England, and by Provincial and Subordinate Services recruited in India. It is by the members of the Imperial Civil Service that the highest responsibilities of administration are borne. That service includes all natural-born subjects of Her Majesty, from all parts of the empire, who choose to enter it, through the open door of competition, in accordance with the prescribed rules. A certain proportion of the appointments, held a few years ago by members of the Imperial Service, are now held by qualified Indians, selected in India, under the Provincial Service Rules, and in a small number of cases by "statutory" civilians, also selected in India, under a special Act. The concessions made under that Act and the Provincial Service Rules are in furtherance of the policy to freely and impartially admit, "so far as may be," British Indian subjects of whatever race or creed to offices in the service of the Crown, "the duties of which," in the words of the proclamation of 1858, "they may be qualified by their education, ability, and integrity to discharge." The object in view in recruiting the Imperial Civil Service by open competition in England—and it is one in perfect harmony with the spirit of that proclamation—is to obtain for the more responsible posts in the administration men possessing such physical, intellectual, and moral qualities as will enable them to bear the severest strain that is likely to be put on them, not merely

in the ordinary course of daily duties, but in times of exceptional stress also; and not only that, but they must be sound exponents also of principles of good government essentially English; men patient to hear both sides in a quarrel; yet capable of quick and energetic action when once a course of action has been decided upon; foes to every form of wrong, brave and self-reliant. We have been able to secure men of the right stamp by the processes hitherto in force, and though we have been taunted with selfishness for practically reserving the Indian Civil Service as a hunting ground for our sons, the fact still remains that a vigorous English schoolboy, of average, or more than average talent, who is adventurous enough to seek an Indian career, and enters the Service after his character has been moulded by the thousand healthful influences and associations of school and university life in England, and of an English home, is about as good material as can be desired for the purposes of the public service in India, as of public life in England; and a youth so equipped for his life's work soon develops all that is manliest and best in him, when he once assumes large official responsibilities, and acquires fresh stores of earnestness and zeal with every year of his official life. And as for the taunt of selfishness, it is scarcely justifiable, for, as I have already pointed out, the requisite material can, under existing regulations, be procured from any part of the empire—from India, from Australia, from the Cape, from Canada. Still, for the present, at any rate, if my judgment is not altogether astray, such material can be best worked up in England for use n India.

I spoke just now of the large responsibilities of Indian Civil servants, and I will now refer more definitely, and yet in general terms, to the kind of duties which individual members of the Civil Service are called upon to perform. And here, again, my remarks, though applicable mainly to the Bombay Presidency, will probably hold good, in a general way, for other provinces also. In India the lowest territorial unit of administration is the village, the Patell or head-man of which represents in his own person the cause of law and order, and, according to his degree, the magisterial and executive functions of the Government generally. Sometimes the duties are shared with a Revenue Patell, and he is assisted by the village accountant, who keeps most elaborate and accurate accounts of the public revenue and other matters. A collection of a certain number of villages constitutes the geographical and administrative area known in the Bombay Presidency as a Taluka, which is under the special charge of a native collector, or Mamlatdar, who is also a magistrate, his head assistant being also generally a magistrate; and a certain number of Talukas constitutes a collectorate or district, at the head of which is the collector, who is also the district magistrate, and is practically the local Governor, invested with large powers for the maintenance of the public peace, through the agency of the district superintendent of police, for the collection of the public revenue, and for promoting in every conceivable manner the well-being of the people. The collectors have each two or more assistants, who are also magistrates, and are controlled by the Commissioners, who are rulers, under the immediate control of the Governor in Council, of divisions consisting each of several collectorates. In the Bombay Presidency, including the Province of Sind, there are four Commissioners. The average area governed by each of them exceeds 31,000 square miles, and is, therefore, a little more than one-fourth of the area of the British Isles. The average population of each commissionership exceeds 4,700,000. That is, it is about one-eighth of the population of the British Isles. Including Sind, and excluding the city of Bombay and Aden, there are twenty-three collectorates or districts in the Bombay Presidency. The average area of each district amounts to 5,436 square miles, and the average population to 784,142. The two members of the governor's council —who, in the Madras and Bombay Presidencies, exercise co-equal powers jointly with the governor, and are appointed to their offices by Her Majesty—the commissioners of provinces or divisions and the collectors and their assistants, with the exception of the small number of officers already referred to, belonging to the Provincial and Statutory Services, are members of the Imperial Civil Service. This is the case also as regards the higher judicial officers, including, in the Bombay Presidency, three of the seven judges of the High Court (who are appointed to their offices by Her Majesty), the judicial commissioner and judge of the Sadar Court (the highest court of appeal) in Sind, the judges of first appeal in each district (who preside in the district courts under the code of civil procedure, and are also sessions judges under the code of criminal procedure) and their assistants. The secretaries and under-secretaries to Government, except in the Department of Public Works, the Municipal Commissioner of Bombay, and the Deputy Municipal Commissioner, the Postmaster-General, the Accountant-General, and some political officers are also at present members of the Indian Civil Service. The offices of Municipal Commissioner, Postmaster-General, and Accountant-General are not, however, reserved by law to the Civil Service. The office of Director-General of Agriculture is also held in the Bombay Presidency by a Civil servant, and the office of Inspector-General of Police at one time was so held. Two of the members of the Viceroy's Council, and the Lieutenant-Governors of Bengal, the Punjab, the North-Western Provinces, and Burmah are also members of the Imperial Civil Service. It is, obvious, therefore, that duties of special importance, on the right performance of which the safety and progress of the empire largely depend, are demanded from the comparatively small staff of officers composing that service. The area of British India, including Upper and Lower Burmah, but excluding the Feudatory

States, comprises about 965,000 square miles, or nearly eight times that of the British Isles; and the population, at the date of the last census, in 1891, amounted to more than 221,000,000, or to nearly six times that of the British Isles. The administrative requirements of this wide extent of territory and this enormous population are provided for by about 1,000 officers of the Imperial Civil Service. That is to say, the proportion, roughly speaking, is one such officer to every 965 square miles of territory and 221,000 inhabitants. Other officers of the higher grades, who are not members of the Imperial Civil Service, are employed on important and responsible duties connected with the control of public works, public education, State forests, medical institutions, and public sanitation. Hence the necessity for special care in recruiting for the higher civil offices of the public service, and the real justification of the policy which is content with no poorer recruiting ground than that which meets so completely the requirements of public life in England. The policy has been justified by its results. The high tone imparted to the civil administration by the great men—soldiers and civilians—who broadly laid its foundations, has been maintained by the civilians and the soldier-civilians who have raised the edifice to its present dimensions; and the touchstone of trouble has, in the recent years of plague and famine, revealed to the whole civilised world the worth of the men who have borne with steadiness the strain which has been put upon them.

The Provincial, Statutory, and Subordinate Services are, as I have already said, recruited in India, and many members of these services have been educated in colleges affiliated to the Indian universities, which were established by the Government of India in the dark days immediately following the outbreak of the Indian Mutiny. Though these universities, by their constitution, are not teaching institutions, but boards having the control of examinations, on the model rather of the London University than of Cambridge, Oxford, Edinburgh, or Dublin, yet, by the exercise of the powers conferred on them by law, for regulating the examinations for degrees and the course of instruction to be undergone by candidates for degrees, they can clearly influence the course of study in all teaching institutions. The avowed object of their establishment was "the better encouragement of Her Majesty's subjects of all classes and denominations . . . . in the pursuit of a regular and liberal course of education." But quite apart from any considerations having reference to the advancement of learning, it may be assumed that one of the principal objects of the Government of India, in making provision for the requirements of higher education, was to raise up a staff of indigenous officers, well prepared by a course of liberal education, in the English sense, to appreciate and assimilate our methods of civil government and so to become qualified to take their share in the work of administration, in co-operation with the officers who enter the Imperial service by open competition in England. Such an assumption is entirely consistent with the terms of the proclamation of 1858; and in the Bombay Presidency, of which alone I can speak from personal knowledge, the policy of our University Acts, which must be regarded as an essential feature of our Imperial system, has been successful; certainly so far as the Hindu and Parsi communities of that Presidency are concerned; but, unfortunately, as regards the Mahomedan community, which has never fallen into line with our educational policy, no such proposition can be affirmed. Young Mahomedans, as a rule, avoid our educational institutions, and thus fail to acquire the requisite qualifications for the public service.

From a statement prepared for me by the Registrar of the Bombay University, two years ago, it appears that, in 36 years, 3,641 degrees had been conferred in the four faculties of arts, law, medicine, and civil engineering. It is estimated that, during the same period, 1,200 graduates had entered the liberal professions in the Bombay Presidency and that there were, in 1897, about 465 graduates in the public service of that Presidency, of whom 182 were employed in the Educational Department. We have thus succeeded in securing the co-operation of educated Indian officers which has been of the highest value. In the judicial, revenue, educational and public works departments, and also in the departments which deal with medical affairs, the administration of hospitals and dispensaries and public sanitation, educated Indians are rendering efficient and loyal service, and in some conspicuous instances, brilliant service of a high order. Indeed the great majority of Civil officers are necessarily and always have been natives of India, though the fact seems sometimes to be lost sight of.

I should like to say a few words regarding the state of the several departments which, in Western India, are classed under the general head of "judicial," and are the departments mainly concerned with the protection of life and property, and the administration of justice; that is, in securing for the people of India some of the special benefits which Sir Raymond West has described as peculiarly characteristic of British rule. The police force throughout India has, in recent years, been called upon to discharge duties which have been exceptionally severe and has acquitted itself satisfactorily. When serious riots occurred, a few years ago, between Mahomedans and Hindus in many places, far apart from each other, they were invariably put down with promptness and vigour by the ordinary police force, with the aid, of course, of the troops in exceptionally serious cases; and the utmost vigilance was used to prevent possible disturbances of the peace in places where the relations of the two communities were known to be strained. It was only the restraining presence of British authority that often prevented bloodshed and rapine; and indeed, as I have already observed, the maintenance of public order is the key-stone of our administrative system,

on which depends the stability of our whole scheme of impartial government. It is by the systematic repression of all forms of lawlessness that we place ourselves in a position to give effect to plans for the welfare of the people. As regards the police of the Bombay Presidency, much undoubtedly still remains to be done for its improvement, especially in the unarmed branch employed on the detection and investigation of crime. Its deficiencies have not been overlooked, and the entire force has been reorganised within the past few years, one of the objects having been to secure a better class of men for these particular duties.

And when crime has been detected and the offender brought before the magistrate, the proceedings are thenceforth conducted by the criminal courts with the fairness and regularity demanded by the provisions of the Criminal Procedure Code of 1882, which has assumed its present comprehensive form only after repeated deliberations in the Council of the Governor-General, beginning with the year 1860—the year in which Macaulay's famous Indian penal code was enacted—which has stood the test of time, having been rarely amended by subsequent Acts. The decisions of the criminal courts, according to their grades, are subject to appeal to the District Magistrates or to the Courts of Session or the High Courts; and the proceedings of all courts of inferior jurisdiction are subject to revision by the High Courts. Every opportunity is afforded for the rectification by a superior court of irregular or illegal proceedings prejudicing the course of justice; and there can be no sort of question that the people appreciate our judicial system, as administered under the judicial control of a succession of most capable Chief Justices and Judges in the several High Courts. It is in the administration of justice in the civil and criminal courts that native talent has most effectively aided the cause of good government, the great majority of the magistrates throughout the country and the judges of the civil courts of first instance outside the Presidency towns being Indians, who are represented also in the District Courts and the High Courts. In the Bombay High Court two of the seven judges are Indians. And as regards the judicial branch of the Provincial Civil Service, I have no hesitation in saying that, in the Bombay Presidency, at all events, it has distinctly improved in tone during the last thirty years; and I would add that, though this improvement is due partly to the enhanced attractions of the service, consequent on a liberal revision of salaries, it must also be ascribed in part to the extension of higher education. In the Bombay Presidency, about 25 per cent. of the Subordinate Judges (who are members of the provincial service, and judges of the civil courts of first instance, a few only having appellate powers) are graduates, yet the remaining 75 per cent. have qualified themselves for their appointments by passing a severe examination in law prescribed by the High Court. The judicial service is, therefore, practically manned by the educated classes.

And here I should like to direct your special attention to some noteworthy matters connected with the actual administration of justice in British India. Although, in respect of criminal proceedings, the legislature has (by chapter 33 of the Code of Criminal Procedure of 1882) made special provision for the trial of European British subjects, who, in certain cases can, if so advised, claim that the presiding magistrate or judge shall himself be a European British subject, yet in civil matters, in all courts of original jurisdiction outside the Presidency towns, they have no similar privileges, but must sue or be sued before the presiding judge, whatever his nationality may be, that is, practically, before a native judge. "Equality, uniformity in such matters," as observed by Sir Raymond West, "has appeared to the English as the natural and necessary course of things. To any other dominant people it would have been intolerable."

And then, again, chapter 27 of the Code of Civil Procedure provides for the institution of suits against the Secretary of State in Council, or any public officer, in respect of acts done in an official capacity. Subject to certain exceptions, enacted in the Bombay Revenue Jurisdiction Act of 1876, the legality of any executive action taken by the Government, or by any officer of the Government, can thus be questioned and redress obtained by the injured party, in proper cases, in the civil courts having jurisdiction in such cases. England is, I believe, the only European country in which any similar system is in force.

And, again, since the days of Warren Hastings, respect has been shown for the ancient usages and institutions of the country by the adoption of a policy, at once truly sympathetic and considerate, in pursuance of which our civil courts decide all disputes as to rights of inheritance and succession, and the devolution and distribution of property, and various other civil matters of vital importance, in accordance with the personal law of the party concerned; that is, according to the Hindu law or the Mahomedan law, as the case may be; though, as regards the administration of criminal justice and the application of rules of evidence and procedure to judicial proceedings, and also as regards certain civil matters provided for by express enactment, the laws of British India prevail generally.

When offenders are sentenced to imprisonment or transportation, their lives are thenceforward regulated according to a system of jail management, the details of which have been settled by some of the best minds in India. I doubt whether any other country possesses a punitive and reformatory system worked on sounder principles than that in force under the Indian Prisons Act of 1894. The late Austro-Hungarian Consul-General in India, Herr Schmucker, once expressed to me the surprise and pleasure it gave him to inspect the arrangements at the great Central Jail at Yeraoda, near Poona, which he described as admirable beyond all his anticipations.

In conclusion, I will adduce a few facts only in

illustration of Sir Raymond West's third contention as to the material prosperity of the people which the Indian Government has always striven to secure. I have already spoken of the evidence of increasing wealth in the city of Bombay, and similar indications are not wanting elsewhere. I do not propose to give even a summary of the operations of the departments more immediately concerned with the material advancement of the Indian ryot—of such departments, for instance, as the great Land Revenue Department, the Forest Department, the departments concerned with agriculture and mineral resources, or with the control of factories, and the great Public Works Department, which is concerned not only with public buildings and ordinary civil and military works, but with railways and other means of communication, and with irrigation schemes. The most cursory perusal of such an official document as the Statement, exhibiting the moral and material progress and condition of India, annually presented to Parliament, will serve to show how wonderful the progress has been. "Practically," as Sir Raymond West observes, "a new world has been created, a new faculty conferred on the millions heretofore condemned to live and die in stagnation, prevented from gathering the riches of the teeming earth by physical, political, and fiscal isolation." A measure, the merits of which have been much discussed, is the Bombay system of survey and settlement, on which, as on all such systems throughout India, the welfare of the peasantry must largely depend. Though this particular system may have its defects, there is nothing, so far as I know, to show that the general standard of comfort in the rural districts was ever so high under any former rule as it is now in British territory. The general condition of the people has, I believe, vastly improved in our time; and on this point I can adduce the evidence of Sir Bartle Frere, contained in a speech made in the Bombay Legislative Council at the time when the Survey and Settlement Act of 1865 was under discussion. One of the strongest opponents of certain provisions of that Act, the late Rao Saheb Wiswanath Narayen Mandlik, a man of sturdy independence of character, whose worth was recognised both by the Governor and by the Viceroy, of whose Legislative Councils he was a member, was always ready to bear cordial testimony to the advantages generally conferred by our revenue system on the Indian ryot. And then such specific facts and figures as these, taken almost at random from the last Material and Moral Progress Statement, speak for themselves. Inclusive of a few mills in feudatory States and in French territory, there are now 163 cotton mills in India worked by steam, of which 114 are in the Bombay Presidency. They represent a nominal capital of 150,000,000 rupees, and employ a daily average of more than 148,000 hands. They contain nearly 37,000 looms, and 4,210,756 spindles, and use more than 4,500,000 cwts. of cotton. This industry dates only from 1851, when the first mill was started. Since 1879 it has increased threefold.

Among other large industries reported on in the Statement are 7,612 indigo factories, 1,745 saltpetre refineries, 674 cotton ginning factories, cotton presses, jute presses, 174 oil mills and wells, 151 tanneries, 134 clutch and lac factories, 109 pottery and tile factories, 96 sugar factories, 86 iron and brass factories, and, in small numbers, silk mills, soap factories, coffee works, cotton and woollen spinning and weaving establishments, not classed as mills, rope factories, flour mills, ice factories, bone crushing factories, tobacco and cigarette factories, and dye works.

The largest number of factories subject to the Indian Factory Act is in the Bombay Presidency, there being 130 in the City of Bombay alone; and factory labour there is attractive, the condition of the factory hands being somewhat better than that of the ordinary cultivators.

In reference to the tea industry in Assam, I note the fact that, in 1897-98, the number of persons working in tea gardens increased from 465,000 to 478,200. The number of labourers who immigrated into Assam was 95,900, as against 81,000 in the preceding year. Throughout India the tea gardens employ 662,000 labourers. The total exports of Indian teas by sea increased from 78,750,000 lbs. in 1886-87 to 151,500,000 lbs. in 1897-98. About 137,000,000 lbs. were exported in the latter year to the United Kingdom; and, whereas, in 1865, only 2 per cent. of the teas imported into the United Kingdom were Indian teas, 93 per cent. being from China, in 1898 India sent 53 per cent. of our tea imports, the per-centage from Ceylon being 36, and that from China only 10. The exports of tea by land into neighbouring countries amounted, in 1897-98, to 870,000 lbs., and the value of the total tea exports to more than 80,000,000 rupees.

Again, in 1898, the railway lines on the standard metre and special gauges extended to 21,865 miles, as against 20,877 in 1897. With an increase of more than 4 per cent. in the open mileage, there was an increase of about $7\frac{3}{4}$ per cent. in the net earnings. The total number of passengers in 1898 showed an increase of 461,373, and the number of tons of goods handled an increase of 1,732,070, as compared with 1897.

These are mere samples of the results recorded; but I trust I have said enough to show that England has done her duty by her great dependency, and that the system of civil administration she has established in India is a sound system, capable, so long as the civil establishments are rightly recruited and wisely controlled, not only of meeting the present wants of the country, but of steady development also, in view of future requirements.

MINERAL STATISTICS.

The third part of Dr. Clement Le Neve Foster's "Report on Mines and Quarries for 1898" has just

been issued. It contains the statistics relating to the output and value of the minerals raised in the United Kingdom, the amount and value of the metals produced during the past year. The total value of all minerals raised in the United Kingdom in 1898 exceeded £77,000,000, an increase of more than £5,000,000 compared with the previous year. This increase in value is mainly attributable to the higher prices obtained for coal, thus the quantity of coal obtained in 1898 was 202,054,516 tons, as compared with 202,129,931 tons in 1897, while the value at the mines in 1897 was £59,740,009, and in 1898, £64,167,382.

Taking the various divisions of the United Kingdom separately, it appears that England produced minerals worth £55,000,000, Wales £10,500,000, Scotland £11,000,000, Ireland less than £250,000. The principal mining counties, whether judged by the minerals produced, or number of persons employed, are:—Durham, with an output of 34,737,347 tons of coal; Yorkshire, with 25,639,021 tons of coal, and 5,785,588 tons of iron ore; Lancashire, with 24,324,685 tons of coal, and 749,429 tons of iron ore; and Glamorganshire, which yielded no less than 19,140,742 tons of coal, in spite of a strike lasting five months. In these four great coal counties is concentrated nearly one-half of the mineral industry of the kingdom.

The export of coal was about half a million tons less than in 1897, but it still amounts to 36,500,000 tons, and Dr. Foster considers that this is quite enough to cause anxiety in the minds of those who dread the depletion of the national supply.

Dr. Foster adds that the proper husbanding of the coal resources of the kingdom is a question of national importance, and he calls attention to the warning of Mr. T. Forster Brown, who, in his paper upon "Our Coal Supplies," read before the Society of Arts (*Journal, ante* p. 596), stated that in another fifty years the dearth of cheap coal will begin to be felt.

In the case of iron ore the British mines and quarries are increasing their supplies, though the total output is still nearly 4,000,000 tons below the high-water figures of 1880 and 1882. In the case of the ores of copper, tin, and zinc higher prices for the metal have had the natural effect of increasing the output, but even this stimulus has been insufficient to prevent the continuous fall in the production of lead ore. A small quantity of gold continues to be found in Merionethshire, but in 1898 the output dropped to 395 ozs., the amount obtained for which as bar gold was £1,299. The amount of gold obtained in 1897 was 2,032 ozs.

PEAT FUEL IN CANADA.

According to the United States Consul at Stratford (Quebec) the most serious problem that confronts the Canadian people of the future is material for fuel. The gigantic lumber industries and the great annual forest fires have so denuded the timber area of Ontario that the people are thoroughly alarmed about the future fuel supply. It has been well known for years that there were extensive beds of peat bogs in Canada and particularly in the province of Ontario. An effort has been made during the past six months to utilise this product of nature, and the recent invention of machinery, by means of which vast areas of hitherto unused bogs can be converted into marketable peat has opened up a new Canadian industry. The origin of peat bogs is well understood. They occur in low situations or where some natural or artificial obstacle impedes the drainage. Abundant moisture favours the growth of a low order of plants, such as the *sphagnum* mosses. This plant is noted for its absorption of water. Its structure is that of reservoirs in successive layers, which are kept filled by capillary attraction, even when the plant itself is above water level. The same properties of the moss tend also to its decay. It requires a constant supply of moisture, yet it is continually pumping up to the surface of its tufts the water in which it stands, thus promoting evaporation, while at the same time, by regularly decaying at the roots, it deposits the detritus which adds to the solid contents of the bog. This process goes on until the bog is raised above the level of the surface waters, when *sphagnum* vegetation ceases. The best authorities say that there are 100,000 acres of this undeveloped peat bog in Ontario, principally in the counties of Perth, Welland, and Essex. The largest area lies in the county of Perth, eight miles north of the city of Stratford, on the Grand Trunk Railroad that extends from Port Dover to Owen Sound. Here is a swamp of 40,000 acres with a depth of great bog that varies from a foot to 20 feet. About a year ago the Canadian Peat Fuel Company was organised, and early in the summer active operations to put the fuel on the market began. The process of manufacturing is as follows:—The peat is cut and air dried, after which it is pulverised by being passed through a pickler, and automatically deposited in a hopper which feeds a steel tube about two inches in diameter and fifteen inches long. The pulverised peat is forced through the tube by pressure and formed into cylindrical blocks three inches in length and almost equal in density to anthracite coal. In weight the fuel compares with coal as follows:—83 pounds per cubic foot of peat equals 73 pounds of bituminous, or 93 pounds of anthracite coal. It is claimed for peat that it is superior to coal in its absolute freedom from sulphur and the absence of smoke, soot, dust, and clinkers during consumption. In a great measure this solves the problem of furnishing a cheap, clean, uniform, and reliable fuel for all domestic purposes, as it is equally serviceable for grates, stoves, cooking-ranges, and furnaces, giving a long bright flame and intense heat almost from the moment of ignition. It has been tested in locomotives with excellent results, showing that the thermal value of 100 pounds of peat is equal to 95.15 pounds of coal. It was also tried at the power-house

of the Metropolitan Street Railway, Toronto, and gave great satisfaction. The heat produced was much greater than that of coal, but it was 8 per cent. deficient in lasting power. The machinery used in manufacturing fresh fuel is not expensive and requires but little attention when in operation. The company claims that when the works are fairly started it can produce compressed peat fuel for about 2s. 6d. per ton.

COTTON INDUSTRY.

The Board of Trade returns for the past month respecting our total shipments of cotton piece-goods show an increase on the same month of last year and the year before. The figures for the past nine months are:—4,096,376,400 yards; the amount for the same period in 1898 was 3,842,208,100 yards.

The countries showing an increase this year on the same period in 1898 are:—

	Yards.
Bombay	95,900,000
Bengal and Burmah	63,600,000
Foreign West Indies	36,600,000
China	25,300,000
Morocco	23,600,000
Venezuela	21,500,000
U.S. of America	18,600,000
Central America	10,000,000
Chili	10,000,000
Phillipine Islands	9,300,000
Madras	8,700,000
Egypt	6,300,000
Dutch Possessions in India	5,800,000
West Coast of Africa, Foreign	5,500,000
Portugal	5,500,000
Persia	5,300,000
Mexico	4,500,000
West Coast of Africa, British	4,100,000
Republic of Colombia	3,600,000
Canada	3,600,000
Australasia	3,300,000
Greece	2,700,000
France	1,700,000
Argentine Republic	1,300,000

The chief cases of decrease are:—

Brazil	47,800,000
Turkey	40,000,000
Japan	23,700,000
Straits Settlements	14,600,000
Germany	8,600,000
British Possessions in South Africa	5,600,000
Uruguay	2,700,000
Malta	900,000
British West India and Guiana	800,000
Italy	800,000
Austrian Territories	500,000

A feature of interest in our shipments so far this year is that India has taken about 44 per cent. of our total exports of calico. China has done fairly well, and so has the United States. Japan is doing a little better at the moment, but during the last three-quarters of the year she has disappointed Lancashire. Manufacturers in this country continue, on the whole, deeply engaged for some months to come. All available looms are fully at work, and it would not be surprising, in view of the present state of affairs, to see more loom sheds erected in North and North-East Lancashire. The margin between cotton and cloth and between yarn and cloth has been more remunerative than for some time back. The whole appearance of the weaving trade is healthy, with no discouraging prospects for the next six months. The recent upward movement in cotton has restricted business to an important extent; that is to say, few contracts from the great consuming markets of the East have been placed at the advanced quotations. Business, in point of fact, has been upset. Until the raw material assumes its normal state, trade will not be fully resumed. The home department is also healthy, with no special feature worth mentioning.

Our shipments of cotton yarn for last month were pretty much the same in weight as in the corresponding month of last year, but the aggregate shipments for the past nine months do not look well as compared with the same three-quarters of the year 1898. The amount for the nine months ended September 30th, 1899, was 160,214,100 lbs., while for the same period in 1898 the amount was 184,140,400 lbs.

Lancashire spinners from American cotton for home consumption have all this year experienced a fairly remunerative trade, Just now, as previously stated, business has been largely restricted by the important advance in cotton. Users of cop twist and weft have operated very sparingly indeed. We should say that during the last month scarcely one-third of the output of the spindles has been sold, still producers have heavy order-books, though they are lighter than a month ago. The production is fully absorbed by the looms, no stocks being heard of in any direction. There are a number of new mills being built, and last week several additional factories were projected. It looks as if in twelve months' time from now there will be close upon 1,000,000 more spindles running than to-day. Shipping yarns have rather lagged behind. Bolton spinnings have been very strong indeed. It is a long time since the finer counts were so deeply under contract.

Mr. Henry Neill has made a statement of a definite character relating to the probable growth of the American cotton crop. He considers that there will be a yield of at least 11,000,000 bales, however early a real killing frost may come. These figures are to be looked upon as his minimum estimate. Other authorities have given out lower figures, and it remains to be seen what the output will be. In the meantime Lancashire spinners, on the whole, are putting their faith in Mr. Neill. During all the recent excitement they have bought sparingly on spot, not being disposed to follow the upward course of prices. The Egyptian cotton crop is understood to be of satisfactory dimensions.

An agitation is on foot amongst cotton operatives to reduce the hours of labour by one hour, the present legal time being 56½ hours. The Cotton Employers' Parliamentary Association, which covers the whole of the staple industry, are preparing to strongly oppos the proposal in view of the keen competition abroad and the longer hours worked there. The masters' secretary (Mr. W. Tattersall) has asked the Foreign-office for a return of the hours of labour in foreign cotton mills.—*Economist.*

CITY AND GUILDS INSTITUTE.

The annual report of the Examination Department of the City and Guilds of London Institute for the advancement of technical education for the session 1898-99, has just been issued, from which it appears that the total number of students in the classes registered by the Institute was 36,155 as compared with 34,990 in the previous session, and the number of candidates examined was 14,978 as compared with 14,148.

The exhibition of the students' practical work, executed in connection with this year's examination, was on a larger scale than usual, and was arranged in the North Gallery of the Imperial Institute. The exhibition was opened on June 9th by the Duke of Devonshire, Lord President of the Council, who in his address reviewed the work of the Institute.

Its special work has been to supplement the scientific and artistic teaching of the Science and Art Department by practical classes in what is termed "technology"—*i.e.*, instruction whose object is to familiarise a student with the processes and details required in the trade for which he is destined, and to show him how the knowledge he has acquired at lectures or from books may be applied to the practical performance of his business.

The record of the Institute's work is a tale of continual progress. In 1885, six years after its commencement, there were 263 classes held at 167 centres, attended by 6,396 students. In the year just ended (1898-99) there were 1,764 classes at 397 centres, attended by 34,176 students, the number of subjects for examination being 63, as compared with 42 in 1885 and 24 in 1880. The number of candidates' papers was 14,004, and the number of passes 7,962. The subjects which attract the largest number of students appear to be wool and worsted weaving, cotton spinning, cotton weaving, telegraphy, and telephony, electric lighting (preliminary work), plumber's work (preliminary), typography, carpentry and joinery, dressmaking, millinery, and plain cookery. The committee report that the relations between the Institute and various trade organisations have been strenghthened and widened during the past session, and the examinations in typography and millinery are specially mentioned in this connection.

The operations of the Institute are not confined to London. In 276 towns of the United Kingdom technical instruction is given in connection with the Institute, while examinations have been held this year in India, New South Wales, New Zealand, Barbadoes, and Jamaica. Applications have been received for the holding next year of examinations in other colonies. It is in the large manufacturing towns of the north that most energy has been thrown into technical instruction. Manchester and Salford, for instance, with a united population of three-quarters of a million, have nearly half as many students as London, with a population of four and a half millions.

The committee note with satisfaction that the powers of the new Education Board have been so widened as to enable it to recognise the educational work done under the direction of the institute. It is now generally understood that technical education must form a distinct branch of that Board's work; and a well-organised Technical Instruction Department will probably include sections for science, art, technology, and agriculture. The work of the City and Guilds of London Institute will thus fall directly within the scope of the reorganised Education Department. Its committee recommend that the teaching of technology be placed on the same basis in regard to State aid as that of science and art.

LIQUID AIR AS A BLASTING AGENT.

The *St. James's Gazette* quotes from a foreign source an account of a series of tests of liquid air made a few weeks ago by the Vienna Crystal Ice Company in the presence of representatives of the Austrian Technical Military Committee. The fluid was obtained from Linde's works in Munich, and conveyed to Vienna in open flasks, having the Dewar vacuum jacket to check evaporation. When it was dispatched the mixture contained 75 per cent. of oxygen; but 72 hours later, when the stuff was used, enough nitrogen had evaporated to make the per-centage of oxygen 85. Cartridges were made of liquid air, mineral oil (petroleum), and Kieselguhr. The oil seems to have taken the place of charcoal in gunpowder in supplying an inflammable material which would develop a large quantity of gas. The liquid air was almost pure oxygen, and tended to promote combustion. The Kieselguhr served the same purpose that it does in dynamite. It is a silicious earth used as an absorbent to hold the nitro-glycerine. The cartridges are spoken of technically as "oxylignite." They were prepared in two ways. First, the Kieselguhr and oil were mixed in a basin, and the liquid air was added gradually. The resulting paste was ladled into the cartridge case, which was coated with asbestos, probably to check the absorption of heat from surrounding substances. The second method of preparation was to charge the cartridge with Kieselguhr and oil, and add the liquid air later. The second set of cartridges were encased in sheet lead. Owing to the intense cold the men did not care to handle the cartridges vigorously,

and there was difficulty in attaching detonators and fuses. In the meantime much of the oxygen evaporated, especially from the cartridges having lead cases. These latter proved weaker than the first set. One of them missed fire altogether. The cartridges were inserted in holes thirty inches deep in the rock when fired. Artillery General Engineer Hess made the following comment on the tests:—"The preparation of the cartridges is wasteful and dangerous to the eyes, and, owing to the rapid evaporation, it is further impossible to guarantee the strength of the cartridge, even in the roughest way. Kieselguhr and oil seem to be suitable absorbents, and oxylignite an effective blasting agent, though comparative tests have not been made yet. The cartridges must be used within, say, fifteen minutes of their preparation. There is no danger, hence, from missing fire. But, on the other hand, it will be difficult to fire many cartridges simultaneously, and, strictly speaking, the cartridges should be made on the spot, and be in a very hard condition. That would scarcely be possible below ground; the spurting liquid might break the glasses of the hot safety lamps, and it remains to be investigated whether the large volumes of oxygen might not lead to spontaneous ignition of marsh gas or coal dust. The evaporating oxygen would, on the other hand, improve the air, and the blasting would not contaminate it."

AUSTRALIAN QUICKSILVER.

Although quicksilver has not hitherto occupied other than a minor position among the metals of New South Wales, there are indications that in the near future it will be found one of the most valuable of the numerous metallic products of the colony. The presence of native mercury, or quicksilver, in New South Wales was ascertained so far back as 1841, when the Rev. W. B. Clarke, the well-known Australian geologist, received a sample from a creek on the Cudgegong River, an auriferous stream, rising in the Australian Alps, and flowing through a portion of the western goldfields of the colony. Cinnabar had previously been found in the same locality. It has also been discovered in a few other places, but although Mr. Clarke, with a view to stimulating systematic search for the metal, published a popular description of the ores of mercury, little or nothing further was done. In later years mercury, in the form of cinnabar, was found at Bingara, where there are several diamond mines; in the vicinity of the Solferino goldfields; and at Cooma, at the entrance to the New South Wales snow country, where the assays of ore yielded 25 per cent. of quicksilver. The richest deposits have, however, been discovered near Yulgilbar, in the Clarence River district, one of the most fertile and beautiful in Australia, sugar cultivation being a staple industry. Some four years ago prospecting was carried on in the hope of finding a payable quicksilver deposit, and the New South Wales Department of Mines dispatched its mineralogist, Mr. J. E. Carne, to inspect and report upon the workings, with the result that that gentleman, after a most careful examination, recommended that a portion of the Government prospecting vote be devoted to assisting the prospectors in their search for the lode which was suspected to exist, and, if successful, to ascertain whether or not the deposits would eventually become payable. Since then considerable developments have been made, and six distinct shafts have been put down on three parallel lodes. Several tons of the ore from these lodes have been brought to Sydney, and quantities of it distributed among the various Government departments for examination and testing purposes. The ore is expected to yield from 3 to 5 per cent. of mercury, and it has been ascertained that the "spent" ore contains gold and silver. The area of the ground examined by the Government geologist is about 120 acres, but it is believed that with the progress of prospecting operations other lodes, more or less rich, will be found. A further examination of the locality is being made by the Government geologist, and his opinion is being anxiously awaited. He has definitely ascertained the existence of three distinct parallel lodes, the first discovered in the colony, and improving as they go down. When the quicksilver mining industry is fairly established, a large population will become attracted to this part of the colony, which has been for many years portion of an immense pastoral property, and but little known. Machinery is being erected, and a preliminary testing of about one thousand tons of ore will be made. Should the results prove satisfactory the New South Wales quicksilver trade will become revolutionised, as the poorest assays show the ore to be richer than those of the American and Spanish mines. They will also encourage the search for other cinnabar deposits, which, there is every reason for believing, are more numerous and richer than generally assumed. The value of the discovery in connection with the colonial gold-mining industry can hardly be overestimated. It simply means that the work of gold production will become enormously stimulated, thereby greatly increasing the already large auriferous output of the colony.

ELECTRIC HEATING.

The new Carmelite Hospice on the Canadian side of the Niagara Falls is provided with complete electric heating and cooking apparatus, and the following description of the installation, taken from the *Electrical World and Engineer*, is printed in *Science Abstracts*:—

"Three-phase current at 2,200 volts is carried on No. 3 bare copper wire from a supply station distant two miles. It is transformed to 110 volts by two 30-kilowatt and one 25-kilowatt transformers at the Hospice. A switch-board, with double-throw switches,

controls two phases of the current, and the third phase is controlled by an adjacent switch-board, and is used for cooking, lights, &c. Power amounting to 100 horse-power is taken by contract, 25 horse-power of which are used for lighting (200 16-candle-power lamps), cooking, and heating water, while the remaining 75 horse-power is applied to heating the lower floor of the building, containing eleven bed-rooms, dining-room, reception-room, and corridor. Each bedroom is 15 × 12 × 10 ft. high, and contains one 4 horse-power heater, with two heats. The corridor is 120 × 15 × 10 feet high, and contains nine 4 horse-power heaters. The kitchen contains one electric range and three ovens. The range has 6 square feet of heating surface, each square foot consuming 15 amperes, and having a two-heat switch. The small ovens take 23 amperes at 110 volts, and the large one 50 amperes. Four 25 lb. roasts can be handled at one time. The pantry has three 5-gallon electric urns for tea, coffee, and hot water. Close to the switch-board are two electrically-operated boilers, one holding 400 gallons and the other 150 gallons. The former, which supplies the laundry and baths, takes 120 amperes and has three heats. The latter supplies the kitchen, and takes 125 amperes, being principally used for quick boiling. On the opening day the kitchen electrically cooked dinner for 250 people. The big boiler will heat water from 60° Fahr. to 212° Fahr. in six hours. The small ovens bake bread in 18 minutes. The large oven is furnished with a thermometer. The current for water-heating, cooking, and lights costs $25 per horse-power, or $625 a year, while the 75 horse-power used in warming the building is secured at about one-fifth of this price per horse-power. The plant, as a whole, requires little care for its operation, and gives great satisfaction."

STORAGE OF WATER.

Under ordinary circumstances the open storage of water tends to improve quality, owing to beneficial action by aëration and light, and the only exception is in the case of deep-well water. In the vicinity of towns, however, experience has shown the desirability of covering reservoirs, so that dust and other matters floating in the air may be excluded. Different methods have been adopted for this purpose. At Vienna, the main distributing reservoir is covered in by a roof supported on granite pillars, in other places on the Continent and in Great Britain, arched roofs supported on cast iron columns or by groined arches have been largely employed, and the latter form of construction is chiefly followed in the United States. Perhaps one of the most interesting contributions to hydraulic engineering literature of recent date has been a paper presented to the American Society of Civil Engineers. The paper in question evidences careful study and research, whilst the tabulated results add materially to its value. It is mentioned by the author that all the examples of the groined arch in waterworks engineering which have come to his notice are to be found in the United States. As we have already indicated, such applications are by no means new in Europe, and the reservoirs of Menilmontant, Belleville, and Montsouris include notable instances of such construction. The last-named has arching in the "Guastavino" method, which, as a matter of fact, was recently introduced into America. Many advantages are, no doubt, offered by grained elliptical arches; the quantity of material is moderate, there is clear head room in each direction, and the arrangement is favourable for ventilation. Brick has been hitherto chiefly employed as the material, but the use of concrete is now becoming more popular. As a general rule, the cost of the latter may be taken at one-half that of brick masonry, and it is suitable for almost any kind of arch. Piers are more frequently built of brick, and it is probable that no financial or other advantage is to be gained by departing from this practice. There can be no doubt that masonry coverings are pleasing to the eye, and are, at the same time, in every way satisfactory. The cost is, nevertheless, unnecessarily high, and it is likely that other designs will ultlmately supersede groined arches. Concrete and steel tie-bars combined are equally durable, strong, and efficient, besides being considerably cheaper.—*Builder.*

TEXTILE DESIGNS BY PHOTOGRAPHY.

Professor Roberts Beaumont, in his introductory address in opening the Session of the Evening Classes of Yorkshire, described the new photographic process of preparing textile designs invented by Jan Szczepanik, which has attracted much attention, and his remarks on the subject are reported in the *Textile Mercury.*

On behalf of the Yorkshire College, Professor Beaumont recently went to Paris to investigate the invention. One of the results of his visit was that a number of specimens of designs prepared by the new process were on view in the lecture-room. Professor Beaumont also secured the loan of some of the actual apparatus used by Szczepanik.

Professor Beaumont prefaced his address by saying that he had spent a considerable time in examining the inventions of Szczepanik, and had seen designs worked out by the new process in the temporary premises in Paris. He also stated that the Szezepanik Company have already a plant for the preparation of designs at work in Barmen, and that they are about to form a company for the same purpose in Great Britain. The object of the photographic appliances of Szczepanik was to take the artistic sketch, and, without any modification of the same, to enlarge it to scale, to transfer it on to ruled paper or point paper, and mark it with the thousands and millions of dots arranged in the proper orders for the development of the several parts of the pattern, in the weaves necessary for giving to each suitable precision of character

when woven. The methods of working the designs were explained by lantern slides, diagrams, designs, and experiments. Professor Beaumont observed that it had been made plain that the apparatus of Szezepanik was capable of producing designs in which there was considerable diversity of woven detail, so that it was purely a question of whether the designs thus obtained were legible for all practical purposes. It was recognised that there must be limitations to its utility, as there were to all automatic and mechanical appliances. Yet if it could be employed in accelerating the process of designing large patterns, it should have the serious attention of all who desired the further development of the weaving industries. It had been thought by some that if the invention became commercially useful the sphere of the designer would be considerably restricted. This was an unsound doctrine to hold in regard to mechanical and scientific innovation. The place of the designer, the brain worker in textile factories, where fancy and decorative textures are produced, could not be assailed.

WREN'S COPYING INSTRUMENT.

In his fifteenth year Christopher Wren took out a royal patent for seventeen years, for an instrument to write with two pens at the same time, which the young inventor thus describes:—"That by its help every ordinary penman will be enabled to write two several copies of any deeds and evidences from the shortest to the longest lines in the same compass of time and with as much ease and beauty, without any dividing or ruling, as without the help of the instrument he could have written but one. That by thus diminishing the tedious labour of transcriptions of the greater sort of deeds, indentures, conveyances, charters, and all other duplicates, the works of the pen are not only shortened, but the penmen themselves both relieved and recompensed by an honest gain with half the wonted toil. That there will be in both copies thus drawn such an exact likeness in the same number and order of lines, and even of words, letters, and stops, in all places of both copies, that being once severed there shall hardly be discerned any difference between them, except such as are merely casual, as spots and marks in the parchment. That this instrument will, undoubtedly, prevent the mischievous craft of corruption, forgery, and counterfeiting of hands and seals, or if any such foul practice be attempted, will effectually and manifestly discover it; for what will it avail to counterfeit a seal, or the hand that signs, unless a duplicate could be made in every line, letter and dot, like the twin copy, which without the help of the same instrument, is impossible? So expedient might it be to all intents and uses of the State, in matters of the greatest consequence, that public Acts be written by this instrument for testimony and assurance to all times." Wren had scarcely promulgated his invention when others claimed its authorship. These assumptions excited his indignation, and he asserted his right in a letter to a friend, supposed to have been Dr. Wilkins, calling to his mind the circumstance of having seen and commended it "to the view of the then great, now greatest person in the kingdom," Oliver Cromwell. He concludes his expostulatory claim by writing, "Although I care not for having a successor in my invention, yet it behoves me to vindicate myself from the aspersion of having a predecessor."—*The Architect.*

General Notes.

ARTIFICIAL PAVING STONES IN GERMANY.—Artificial paving stones are being successfully produced in Germany. The demand in all larger cities is said to be so good, and the expense attached to their production under former methods is so large, that any improvement on the older systems, whether in saving money or in producing a better stone, will be welcomed by almost all countries. The newest process in Germany is to mix coal-tar with sulphur and warm thoroughly; to the resulting semi-liquid mass chlorate of lime is added. After cooling, the mass is broken into small pieces, and mixed with glass, or blast-furnace glass slag. This powder is then subjected to a pressure of 200 atmospheres, and reduced to the form or forms wanted. The resistance to wear and tear in use is fully half as great as that of Swedish granite. Thus it commends itself through durability equal to that of many stone roads, resistance to changes of temperature, roughness of surface—giving horses a good foothold—and, finally, non transmission of sound. Inasmuch, as the joinings are very small, dirt is avoided, and cleaning is very easy.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, OCT. 30...Farmers' Club, Salisbury Hotel, Salisbury-square, E.C., 4 p.m. Mr. Orlebar, "Foreign Agricultural Education."

THURSDAY, NOV. 2...Linnean, Burlington-house, W., 8 p.m. 1. Rev. Prof. Henslow, "The Proliferous State of the Awn of Nepal Barley." 2. Dr. W. G. Ridewood, "The Hyobranchial Skeleton and Larynx of the new Aglossal Toad, *Hymenochirus Boettgeri.*" Mr. Harold Wager, "The Eye-spot and Cilium in *Euglena viridis.*"

Chemical, Burlington-house, W., 8 p.m. 1. Mr. J. Lewkowitsch, "The Theory of Saponification." 2. Mr. F. G. Edmed, "The Action of Dilute Nitric Acid on Oleic and Elaidic Acids." 3. Messrs. Siegfried Ruhemann and H. E. Stapleton, "Tetrazoline." 4. Mr. Bevan Lean, "Ethylic Dibromobutanetetracarboxylate and the Synthesis of Tetrahydrofurfuran-α-α'-dicarboxylic Acid." 5. Mr. M. O. Forster, (*a*) "Camphoroxime" (Part III. —Behaviour of Camphorxoime towards Potassium Hypobromite); (*b*) "Optical Influence of an Unsaturated Linkage on certain Derivatives Bornylamine."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-sixth Session will be held on Wednesday evening, the 15th of November, when an Address by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman of the Council, will be delivered.

Previous to Christmas there will be Five Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 15.—Opening Address of Sir John Wolfe Barry, K.C.B., V.P.Inst.C.E., F.R.S., Chairman of Council.

November 22.—"National Forestry." By D. E. Hutchins, Conservator of Forests, Cape Town. General Michael, C.S.I., will preside.

[In Mr. Hutchins's absence at the Cape, Prof. W. R. Fisher, of Cooper's-hill, has kindly consented to read the paper on his behalf.]

November 29.—"The Great Seals of England." By Allan Wyon. Richard R. Holmes, M.V.C., F.S.A., will preside.

December 6.—"Artificial Silk." By Joseph Cash. Sir Thomas Wardle will preside.

December 13.—"Sea Angling and Legislation." By F. G. Aflalo.

December 20.—"Bi-Manual Training by Blackboard Drawing." By H. Bloomfield Bare, F.R.I.B.A.

Papers for meetings after Christmas:—

"Electric Traction." Charles H. Gadsby.

"Steam Motors for Common Roads." By John I. Thornycroft.

"The Diffraction Process of Colour Photography." By Professor R. W. Wood.

"Coal in South-Eastern England." By Professor W. Boyd Dawkins, M.A., F.R.S.

"A National Repository of Science and Art." By Professor W. M. Flinders Petrie, D.C.L.

"The Electrical Induction Motor on Mountain Railways." By Professor Charles A. Carus-Wilson, M.A.

"Ventilation without Draught." By Arthur Rigg.

"The Undeveloped Resources of the Bolivian Andes." By Sir Martin Conway.

"The Orloff Process of Colour Printing." By W. H. Ward.

"Continuation School Work in Rural Districts." By H. Macan.

Indian Section.

The meetings of this Section will take place on the following Thursday afternoons at 4.30.

December 14, January 18, February 8, April 26, May 17.

December 14.—"Round the Andamans and Nicobars." By Colonel R. C. Temple, C.I.E.

"India in the 19th Century." By Sir William Lee-Warner, K.C.S.I., M.A.

"The Industrial Development of India." By J. A. Baines, C.S.I.

"New Projects of Railway Communication with India." By J. M. Maclean, M.P.

"Indian and English Criminal Procedure." By Sir John Scott, K.C.M.G., D.C.L.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday afternoons, at 4.30 and the first meeting on Thursday:—

November 23 (Thursday), January 23, February 27, March 20.

November 23.—"Old and New Colombo." By John Ferguson. Sir Thomas Sutherland, G.C.M.G., LL.D., M.P., will preside.

"The Colonies in the 19th Century." By The Right Hon. Sir Charles Dilke, Bart., M.P.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday evenings at 8 o'clock:—

January 30, February 13, March 13, April 3, May 8, 29.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday evenings at 8 o'clock:—

Henry Hardinge Cunynghame, "Art Enamelling upon Metals." Four Lectures.

Lecture I.—November 20.

What enamel is—Various styles of enamelling—Cloissoné — Champlevé — Mediæval art — The Renaissance—Limoges enamels– Choice of a style in enamelling.

LECTURE II.—NOVEMBER 27.

Method of executing Limoges enamels—Preparation of the metal plate, of the enamels—The firing paillons.

LECTURE III.—DECEMBER 4.

The method of making enamels—Fluxes—The metallic oxides.

LECTURE IV.—DECEMBER 11.

The application of enamel to jewellery—Gold working—Gilding.

BENNETT H. BROUGH, "Metalliferous Deposits." Four Lectures.

January 22, 29, February, 5, 12.

E. SANGER SHEPHERD, "Photography of Colour." Four Lectures.

March 5, 12, 19, 26.

MAJOR PHILIP CARDEW, R.E., "The Control, Regulation, and Measurement of the Supply of Electrical Energy." Three Lectures.

May 7, 14, 21.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday Evenings, January 3 and 10, at Seven o'clock, by HERBERT JACKSON, on "The Phenomena of Phosphoresence."

Miscellaneous.

THE KID GLOVE AND KID SKIN INDUSTRY IN FRANCE.

The kid glove industry of Grenoble is of ancient and doubtful origin. The town itself is situated in the centre of the finest kid skin region in France, and is surrounded by mountains where the cheap labour of the peasant women can be economically employed in hand sewing. Several centuries ago Grenoble won a well-deserved reputation for the quality of its gloves. The actual quantity of gloves manufactured was small in comparison with the output of to-day, but it appears that in 1691 the glove corporation of Grenoble was organised and founded, and that ever since that time records have been kept which testify to its importance. Since the invention of the sewing machine this industry has been gradually decentralised, and kid gloves are now made in almost every country of the civilised world. The American Consul at Grenoble says that commercial competition—notably in Belgium, Germany, England, Italy, and Austria—following closely upon the heels of this invention, has been perhaps the chief reason why Grenoble has lost its pre-eminence in this branch of manufacture. It may justly be said, however, that Grenoble always has been, and is still, the centre of the kid glove industry, especially for the finer qualities of gloves. This industry may be conveniently divided into four main branches or departments — viz. (1) The raw skin business; (2) the dressing or alum tanning process; (3) the dyeing or staining process; (4) the actual glove-making, *i.e.*, the stretching and thinning down of the skin to its proper size and thickness, the cutting out into the shape and size required, the sewing together of the different parts, and the embroidering. The quality of the skin is best judged after the dyeing and tanning process is complete, and may be said to be based on the strength, softness, and pliability of the leather, and on the size of the skin, the fineness of the grain, and its freedom from defects, which are mainly caused by scars or diseases. These qualities of the raw skin depend on the care given to the young kid, on its breed, on the nature and abundance of its food, and on climatic influences. The finest kid skins are undoubtedly to be found in France, but this does not mean that French skins are uniform in quality. For instance, in the departments of Savoy and Upper Savoy, the skins, as a rule, are large and heavy, with a fine grain for the size; they are soft and elastic, and at the same time strong, and well suited for men's gloves. The rich pasturage of this country is an important element in the superior quality of these skins as a class. In the region of the Vosges, in the north eastern part of France, kid skins are much smaller and less elastic, owing to the fact that the animals are not so well cared for. Here the poverty of the soil is one of the reasons for the inferiority of the skins. To the west of the Vosges, on the line between Paris and Lyons, the kid skins are of a better quality. Still further west, towards the centre of France, in Touraine especially, where the pasturage is good, and the animals well cared for, the grain of the skin is fine, the skin itself is thin and strong and comparatively free from scars and disease. Farther south, towards the Spanish frontier, the quality of the skin is inferior as a rule, the poorer pasturage and hotter climate having a marked effect upon it. The peasants in this part of France are careless in their methods of work. They neglect the kids while alive, and after they have been butchered, take the skins off carelessly and prepare them for market in a slovenly manner. At least one-third of these skins are so dry that they are fit to be used only as linings for boots and shoes. Kid skins have the same general characteristics throughout the south-west of France—that is, from the Rhone to the Spanish border and the Bay of Biscay. Kid skins generally pass through several hands before reaching the glove maker or his agent. The skins of kids which are bought by the butchers in the towns, and used as a substitute for lambskins, are sold to the skin merchants or their agents. The skins of kids which are butchered by the peasants themselves, are

sold to country pedlars who wander through the region from cabin to cabin, collecting them in order to finally dispose of them at a town fair to the skin dealers or to the agents of the manufacturers, tanners, or large skin merchants. The more important butchers of the large towns sell their kid skins directly to the agents of the glove manufacturers or skin merchants. Formerly the regular fair or market brought together all the dealers in the neighbouring district, who exhibited in the market place their lots of kid skins, varying in number from five, ten, and twenty to several hundreds, and sometimes thousands. These fairs were watched with the greatest interest by those who were in the skin business, as the prices obtained there for skins were an indication of the probable prices for the entire season. This is, to a certain extent, true to-day, but the town fairs no longer play the important part that they did twenty years ago. The railways, the Press, and general education, as well as the enormous importation of skins from the Argentine Republic, Chile, the Cape of Good Hope, Arabia, Mexico, Russia, and Asia Minor have brought about a revolution in the skin business. The leading fairs, where kid skins are particularly on evidence, are held at the following places :—Romans (Drôme), Anneyron (Drôme), St. Marcellin (Isère), Valence (Drôme), Clermont (Oise), Tours (Indre et Loire), Poitiers (Vienne), Lusignan (Vienne), Riom (Puy de Dôme), Aurillac (Cantal), Chalons sur Saône (Saône et Loire). At one time the annual fair at Valence was considered by kid skin dealers to be the most important of all those held in France, because the prices obtained there regulated the year's prices for France, and probably for other countries as well. Its great importance in this business was due to the fact that Valence is situated in the centre of a large, fine, kid skin producing country, and its fair was held at the beginning of the season for the southern central portion of France. These conditions brought many fine lots of raw skins, several thousand dozens, to the Valence fair, which fact was sufficient to draw thither the big purchasers or their agents from Grenoble, Annonay, Paris, and other places. This fair still exists, and its prices are quoted every year, but it has lost its former importance, because its importance being recognised, speculators have manipulated the market in order to bring about fluctuations to their own advantage. In Italy the finest kid skins, many of them equal to the best French skins, come from the north, above the line from Turin to Venice. A heavy coarse skin is found in the neighbourhood of Genoa, and a finer smaller skin in Tuscany. In Rome the kid skins are very small, and the market unimportant. Naples, a great centre for the manufacture of cheap gloves, is noted for a low grade skin, as well as Sicily, Sardinia and Corsica. Those that come from the Abruzzi district, north-east of Naples, are very much better. Switzerland stands next to France in the high quality of skins produced. Spain and Portugal both produce large quantities, but as a rule they are far inferior even to those of Southern France. The best Spanish skins are to be found in Saragossa and the surrounding country. Germany produces a large number of kid skins, of which the best come from Saxony. Bavaria, Baden, Thuringia, and Silicia furnish large quantities. The best Austrian skins are to be found in the Tyrol and Styria, those from Bohemia, Hungary, and Transylvania are not so good. Kid skins from Eastern Europe, Northern Africa, South America, and Mexico are used principally in the manufacture of Suède gloves.

MANGABEIRA RUBBER.

The current number of the *Kew Bulletin* contains an important article on the source of Mangabeira rubber (*Hancornia speciosa*). In consequence of certain objections to its use, the price has been but half of Para rubber. Recently, however, the price of Mangabeira rubber has advanced by reason of the improvement in the purity, and on account of its great suitability, when pure, for certain purposes. In consequence, the disparity between the price of the best sorts and that of Para rubber is much diminished. At the end of last year, a kilogramme (2 lbs. 3 ozs.) of the best Mangabeira rubber sold for upwards of 12 milreis (almost 8s.), a price not far short of that of Para rubber. An additional cause of the advance in price is to be sought in the change in making up the rubber; for, owing to the constant watch which is necessary to guard against adulteration by addition of iron or stones put in to make weight, pieces of rubber only half to three-quarters of an inch thick and two feet long by ten inches broad, the so-called "sheets" of commerce, are welcome in the trade.

Of recent years, the exploitation of this source of rubber has taken a considerable extension. While the intelligent collectors, who start from Bahia and work toward the interior, have only tapped mature trees, improvident itinerant collectors, making their own profit out of the pressing demand of the time, have in many places mischievously drawn on the supply and threatened its continuance.

The chief centres for export of Mangabeira rubber are Bahia and Pernambuco. A large supply is brought down the river São Francisco, and so to Bahia; and from this town, in 1889, 134 tons were exported; in 1892, 4,362 bales, to the value of £22,826; and in 1893, 3,293 bales, to the value of £20,362. From Pernambuco were exported, in 1896, 54 tons to the value of £1,800.* A small amount of caoutchouc from the Province of Matto Grosso (probably Mangabeira rubber) is exported down the Parana through Paraguay, and great quantities from Minas Geraes are shipped through Rio de Janeiro.

Recently the Province of São Paulo has begun to

* Probably an error for £18,000.

demand a place in the consideration of rubber export. Regions here, such as that through which the Mogyana railway runs, are exploited, even by persons coming from Bahia for the purpose, the owners of the land receiving, in return for the permission they grant, one-third of the clear profits. A worker can collect about $6\frac{1}{2}$ lbs. of rubber per diem, and receives on the spot 75 milreis (£2 9s. approximately) per arroba $32\frac{1}{3}$ lbs.). The arroba is sold in London for 200 milreis. In the first half of the year 1898 no less than 76,498 kilogrammes (approximately 78 tons) of rubber were passed over this railway, and yet the railways of Paulista and Sorocaba equally traverse the country where the Mangabeira tree grows. In consequence of the increasing trade, Santos has become an important centre for rubber, and there, as at the town of São Paulo, now exist mercantile houses whose principal concern lies in this business.

In this Province an idea of the importance of cultivating and protecting the tree is arising. Many coffee-planters are turning their attention to the sowing of *Hancornia*, and seed is already hard to procure. The Government hoping, by means of the duty on rubber (now standing at 13 per cent. ad valorem), to recuperate its finances, which have become disordered by the depreciation of coffee, has instructed Dr. A. Uchoa Cavalcanti, Acting Director of the Agricultural Institute at Campinas, to inspect the territory in question; and, further, the Congress of the State has decreed that the Mangabeira tree shall be protected, and its cultivation extended, as is advisable.

Although but little is known so far of the cultivation of Mangabeira, it may be said that there is a considerable probability of it becoming an important tree in rubber-culture. The apparently easy accommodation of the tree to soil and climate, its early and considerable yield, together with the fact that even under the rough treatment of the Indians it preserves its fruitfulness, and also the facility with which it can be cultivated, promise a future. And, taking a wide view of its possibilities, from its presence in the red coffee-growing soils of the west of the Province of São Paulo, it appears suitable for the red earths of the German colonies of Africa, Usambara and Togoland alike, such, for instance, as occur at Misahöhe, in the latter colony. For these soils it promises to be considerably better suited than the Ceara rubber plant (*Manihot Glaziovii*), and the Para rubbers (*Hevea*), and will probably give better results than *Castilloa*, than which it is more hardy, earlier maturing, and smaller.

CHELSEA PHYSIC GARDEN.

The history of "physic gardens" in England begins in the year 1567 when John Gerard, of London, first cultivated a garden for the botanical study of plants; he was followed by the Earl of Danby who endowed a garden at Oxford in 1652; while the most famous example — that of the Apothecaries' "garden" at Chelsea — was founded in 1673. This interesting, ancient, and historic institution has recently been discussed in the public Press with a view to the necessary steps being taken to rescue it from the risk of falling into the hands of the builder, as well as to draft some permanent and satisfactory scheme by which it might continue effectually to promote the scientific and educational purposes for which it was originally intended. Sir Hans Sloane, whose liberal munificence bequeathed a lastingly valuable legacy to the citizens of London, both in connection with this garden and with our "national treasure house," the British Museum, in the year 1722, granted to the Company of Apothecaries the land for this garden, subject to this important proviso that "the said garden may at all times hereafter be continued as a Physick Garden and for the better encouraging and enabling the said Society to support the charge thereof for the manifestation of the power, wisdom, and glory of God in the works of the creation, and their apprentices and others may better distinguish good and useful plants from those that bear resemblance to them and yet are hurtful, and other the like good purposes." The expenses entailed on the Society of Apothecaries in maintaining the garden in an efficient state have undoubtedly been heavy, this financial burden having induced them on more than one occasion to endeavour to obtain some relief from, or possible dissolution of, their trusteeship; thus we find that in 1893 they made application to the Charity Commissioners but with no definite result until 1897 when a Treasury committee, consisting of Sir Henry Longley, Sir W. T. Thiselton-Dyer, and Mr. Spring Rice, made an exhaustive investigation of the whole subject, directing their attention specially to the practical utility of the garden for the purposes of its original foundation—*i.e.*, the scientific and educational study of botany. They thereupon recommended the formation of an entirely new administrative body which would be able to maintain unimpaired the true instructive object of the garden and to furnish the necessary funds for its future welfare and efficiency; consequently the Treasury Committee appointed the trustees of the London Parochial Charities to be the sole trustees of the garden, the committee of management to consist of 17 members. Now the representatives appointed by the trustees of the London Parochial Charities are: the Hon. Mrs. Evelyn Cecil, the Right Hon. Sir M. E. Grant-Duff, Mr. W. Hayes-Fisher, M.P., Mr. R. B. Litchfield, Mr. L. B. Sebastian, Sir Owen Roberts, Mr. Sidney Webb, the Rev. R. H. Hadden, and Mr. Evan Spicer. The Lord President of the Council has appointed the Right Hon. Sir Herbert Maxwell, Bart, M.P., while the Treasury has nominated Mr. A. B. Freeman-Mitford as its representative. The Royal Society is represented by Dr. D. H. Scott, F.R.S.; the University of London by Professor S. H. Vines,

F.R.S.; the Society of Apothecaries, which is to appoint in rotation with the Royal College of Physicians of London, by Mr. J. R. Upton; and the Pharmaceutical Society by Mr. Michael Carteighe. Earl Cadogan, as hereditary "lord of the manor" with concurrent rights, or his nominee, is an *ex-officio* member of the committee, and the Chairman of the Technical Education Committee of the London County Council will in all probability represent that well-known and useful metropolitan parliament. Lastly, we understand that Mr. H. Howard Batten, of 3, Temple-gardens, E.C., is the honorary secretary to this representative committee. We note with pleasure that this ancient "charity" with its endowments will in the future be administered exclusively for the advancement of botanical study, with special reference to the varied requirements of scientific nstruction and original research, to those of our "materia medica" and technical pharmacology, in so far as they relate to the practical culture of medicinal plants, and last, but not least, to the increasing requirements of our general educational system. When for one moment we recall the historic past of this old "Physic Garden," the great and learned men who in bygone days strolled between the neat beds of various herbs and rare plants, when we gaze at the august statue of Sir Hans Sloane standing in the middle of the garden, when we remember that Linnæus himself visited this picturesque field of flowers, that old Thomas Wheeler lectured there to many generations of the "Society's" students, and that the famous Lindley there arranged the plants into their "Natural Orders" in contrast to the old "Linnæan system," we cannot but naturally feel that the efforts to keep alive the floral beauties, the many botanical advantages, and the rare historic associations of this quaint and pleasant garden, are indeed worthy of the sincere support of all intelligent Londoners as well as of our Imperial Government.—*Lancet.*

ARTIFICIAL INDIGO.

In connection with the production of artificial indigo, the following letter from Dr. Armstrong, F.R.S., has just appeared in *The Times*:—

"The question of the likelihood of artificial indigo becoming a serious rival of the natural product, raised in your article of the 4th inst., is of such importance to Indian growers that it is desirable to correct the false impression which might be conveyed by some of the statements made in the letter of Mr. G. J. Lavers in your issue of the 19th inst.

"Quoting Messrs. Mewburn and Ellis's statement 'that eventually synthetic indigo will have a very serious effect on the natural indigo trade,' Mr. Lavers says 'I think not,' and gives as his reason 'that articles dyed with real indigo preserve their colour and wear better than those dyed with substitutes.' Even Messrs. Parsons and Keith, in their letter to Sir William Hudson, which you publish to-day, seem to think that there may be a substantial difference in the properties of the natural and artificial products.

"It should be clearly understood that it is no question of introducing a substitute for 'real indigo,' if by this is meant the blue colouring matter in commercial indigo, but of using a substance identical with that produced by Nature, and differing from it only by being 'made in Germany'—of using an article differing only from that produced in India (apart from the presence of indigo red in the latter) by being of superior quality owing to its freedom from the foreign matters often present to a considerable extent in commercial natural indigo. Unless these impurities play an important part in the dyeing process—and this is improbable—the artificial product should be at least as good a dye in all respects as the natural indigo.

"I am told that, as produced by the Badische Company, artificial indigo does not lend itself to the dyers' use quite so readily as the natural product. Indigo, properly speaking, is not a dyestuff, but an insoluble pigment. To dye with it the blue must first be converted into soluble indigo white. It is said that the artificial substance is not quite so easily reduced to white as is the natural product; but this involves no real distinction. Crystalline substances are often less amenable to treatment than are amorphous ones, and probably little difficulty will be experienced in making artificial indigo just as easy to treat as that from any natural source.

"I had the opportunity when in Germany a few days ago of discussing the outlook with friends interested in the manufacture of indigo. I found them entirely hopeful of success, while in no way disguising the difficulties, and my belief is that Messrs. Mewburn and Ellis have by no means exaggerated the danger ahead.

"No reliance can be placed on a rise in price of crude materials. There should be no difficulty in increasing the production of naphthelene and toluene, should a demand arise; enormous quantities of tar are now allowed to go to waste in coking coal.

"The stake for which the German chemical manufacturer is playing is a very big one—far bigger than was offered by madder 30 years ago. Indigo is more difficult to make than is alizarin, but such is the persistence of the German attack upon the position, and so great is the improvement in our methods, that it is far from improbable that all difficulties will ere long be overcome. The manner in which the German factories are organised for such work is marvellous, and calculated to excite the admiration and envy of all who can understand it. I have been astonished at the progress made only in the course of two or three years since I was last in the Rhine district. Thus one firm I find has a scientific staff of 110 skilled chemists, whilst that of another has risen to no fewer than 150, and the works are in proportion. Nature has no chance in the long run against such odds.

"The one lesson to be learnt, I believe, is that

planters should without delay put their house in order, and seek in every way to improve the cultivation of the plant and the extraction of the indigo from it. It would be interesting to know whether a single competent chemist is at present engaged in studying the subject, and whether the Indian Government has in any way had its attention directed to the importance of scientific aid being given to the industry.

"HENRY E. ARMSTRONG.

"Central Technical College,
"South Kensington,
"Oct. 23."

CUBAN TOBACCO INDUSTRY.

The exportation of cigars from Havana in 1897 and 1898 amounted respectively in number to 123,417,000 and 91,812,000. It is estimated that the increase in the production of tobacco in 1899 will be 40 per cent. more than in 1898. In a recent report, the British Acting Consul-General in Havana quotes some interesting remarks by Mr. Gustavo Bock, and states that there can be no doubt that important measures are necessary for the protection of the tobacco industry in Cuba. To insure a planter the sale of his crop at a price in proportion to the cost of production, it is absolutely indispensable that the present regulations, prohibiting the importation into the island of all foreign manufactured or unmanufactured tobacco, should continue in force, excepting only snuff and chewing tobacco, which have always been imported, and in no way injured Cuban trade or agriculture. Of the many laws and decrees which the Madrid Government has issued to favour this colony none has been wiser than this prohibition of the importation of foreign leaf tobacco, thereby avoiding the importation of a leaf of inferior quality by unscrupulous persons, who after manufacturing the cigar in the way usual in the country, made perhaps with a small portion of Cuban leaf, would export it as genuine Havana. This business would prove most profitable to the adulterator, but in time would totally ruin the reputation of Cuban products, both agricultural and industrial, bringing about a decrease in prices which would cause a cessation in the cultivation of tobacco. The production of tobacco in normal times is estimated at 260,000 bales in Pinar del Rio, Vuelta Abajo; 70,000 bales in Havana (called Partido); 130,000 bales in Las Villas, Sta Clara Remedios; and 100,000 bales in the eastern provinces called Mayari and Gibara: making a total of 560,000 bales. This, on an average of 50 kilogrammes per bale, is equivalent to 28,000,000 kilogrammes, or 62,173,800 lbs. In Vuelto Abajo there is a good deal of uncultivated land, and with permaneut peace and a stable government, protection would be insured to capitalists. It is said that this production could easily be increased in the province of Vuelta Abajo alone to 500,000 bales; the province of Havana, Las Villas, and the eastern provinces, could increase in the same proportion. In the manufacture of cigars, cigarettes, and packages of smoking tobacco for home consumption the following number of bales of tobacco are used:—Vuelta Abajo 140,000, Partido 10,000, Santa Clara 30,000, and Gibara 40,000; total 220,000 bales. This leaves for export as follows:—Vuelta Abajo 120,000 bales, Partido 60,000, Santa Clara 100,000, and Gibara 60,000; total 340,000 bales. At 50 kilogrammes per bale this amounts to 17,000,000 kilogrammes, or 36,956,000 lbs. The United States bonght and imported from the island 20,000,000 bales in 1895, 26,000,000 in 1896, and 4,400,000 bales in 1897. The universal reputation which this leaf enjoys, owing to the excellence of its quality and the perfection of its manufacture, would, it is said, increase three-fold if the industry were promoted. It is to-day the most important industry in the country, and in the province of Havana and Pinar del Rio, it is the foremost. With 100,000 cwts., the following has been manufactured:—For exportation, 250,000,000 cigars; for home consumption, 50,000,000 cigars; making a total of 300,000,000. In addition to this, the manufacture of cigarettes represents a value of from £600,000 to £800,000 per annum. Even if, under the auspices of peace and by the adoption of proper measures for the future of agriculture and the production of tobacco, a brilliant and promising future is assured, the same cannot be said of its industry and manufacture. The future of the former is promising. The latter, besides being handicapped by excessive competition, has the insurmountable obstacle of being taxed by the Treasuries of countries burdened by a heavy national debt. As a proof of the above, attention is called to the following figures, showing the gradual decrease of the manufacture of tobacco in the island, a decrease which nearly reaches 50 per cent. in eight years. In 1889 the number of cigars imported amounted to 250,000,000; in 1890, 212,000,000; in 1891, 197,000,000; in 1892, 168,000,000; in 1893, 147,000,000; in 1894, 134,000,000; in 1895, 159,000,000; in 1896, 186,000,000; and in 1897, 133,000,000. On the other hand, the exportation of leaf tobacco has increased 50 per cent.; from 197,000 bales exported in 1889 through the port of Havana, the exports in 1895 increased, approximately, to 250,000 bales. The exportation of cigars to the United States shows a considerable falling off during the last few years. In 1889, the number exported to that country was 111,000,000; in 1893, 46,000,000; and in 1897, 34,000,000.

EXHIBITION OF TUNBRIDGE WARE.

Tunbridge Wells has awakened to the fact that it has a much neglected industry in its Tunbridge ware, and has lately held a special exhibition of it, old and new together, with examples of kindred work lent from South Kensington Museum. Tunbridge ware is formed by building up slips of wood

having a square or triangular section, to make a pattern. The strips are glued together into a solid block, from which thin transverse sections are cut. These are used as veneers to decorate flat surfaces. Modern pieces of Tunbridge ware have been made containing nearly one thousand different pieces of wood to the square inch. Considerably over one hundred and fifty different kinds of wood are used. Holly is boiled to increase its whiteness, Hungarian ash and maple are steeped in chalybeate water for several days for the purpose of turning them into different shades of grey; oak is sometimes attacked by a certain fungus which turns it into a beautiful blue-green. Artificial dyes are not used. The history of the ware is shrouded in some obscurity, but it seems to have been introduced from Germany by the sale of inlaid woods and toys of German manufacture upon the Pantiles. T. B. Burr, in a history of the town dated 1766, says that it was customary for those departing from the town to take away "Tunbridge fairings to their friends at home." The first record of local manufacture was in 1720, when a man named Burrows started the production of wood mosaics in diamonds, triangles, and stars, some of which are still in existence. The process of manufacture seems to be identical with that used in the production of Indian inlay work, and it seems probable that the impetus to the special method of construction may have been received from the same source. The art in India was introduced into Sind from Shiraz, in Persia, towards the end of the eighteenth century. From thence it was introduced into Bombay in the early part of the nineteenth century. There is an air of Orientalism in the conception of the work and in the skilful manipulation that is required in its execution.

The object of the present exhibition is to show the public examples of old and recent Tunbridge ware, and to stimulate the improvement of its artistic possibilities by the production of new designs. To this end the Technical Education Committee offered premiums in open competition for the best designs suitable for the ware. Mr. Walter Crane adjudged the prizes and gave an address on the opening day. The designs submitted were not satisfactory, owing in all probability to Tunbridge ware being so little known to the majority of designers. The use of the decoration is at present confined to cabinets, tables, tea-caddies, glove and card boxes, picture-frames, and small fancy articles. There is no reason why it should not be used on a larger scale, say for the interior decoration of Atlantic liners or railway carriages. If it were controlled and properly guided it might have a large demand for superior cabinet and furniture decoration. There are at the present time only two firms producing this ware, one of which we are informed is giving up, and the promoters of this revival say that the difficulty they have to face is that it does not pay. It would be a pity for it to die out from lack of public appreciation. Why should not a small company be started, even at a small financial loss at the start, of art students and others under a recognised art director, and set to work, say, for two years to see what can be done with it? At no time has there been so increasing a demand for and interest in good inlay work: witness the interest in and prices taken for inlay work of the Queen Anne period; and we must credit the public with admiration for the decoration as for its antiquity. They like inlay work because it adds interest to common and familiar things about their house, and they would sooner have things that so grow into their affections of decorative value than the ugliness of early Victorian furniture.

The exhibition is strengthened by objects from South Kensington Museum, inlaid and marquetry work at its best, which should rouse some enthusiasm in those who have the future welfare of this art before them. The exhibition is a conscious cultivation of art, and an endeavour to interest the public in its life and preservation by calling special attention to the most important side of art, that of decorating utilities by giving them genuine artistic finish, the work of cultivated minds as opposed to trade or shop standards of excellence. "For the hand can never execute anything more beautiful than the character can inspire."—*Builder.*

AGRICULTURE IN MEXICO.

In Mexico irrigation is necessary in the greater portion of the country, and, on account of the scarcity of water, a large extent of land cannot be utilised. When the owner of land has sufficient water for the purpose indicated, he retains his property, and rarely can be induced to sell, as it is of permanent value to him. For the last three hundred years large tracts of land have been owned by individuals or families, who have spent heavy sums of money for canals and dams in order to make them productive. The United States Consul-General at Monterey says that on account of this, and the attending expenses of irrigation, there are fewer small farmers in Mexico than there are in the United States. Until recently farming in Mexico has been of the primitive order; but the Mexican is an expert in irrigation, and if he can get the water, his land becomes fertile and yields generously. During the last two decades decided improvements have been accomplished through the introduction of modern improvements into farming in Mexico. The increase in production corresponds to the improvements in farming apparatus. The great railroads of the country have been important factors in this advance, enabling farmers with a surplus of production to supply those less fortunate. The cost of labour is from 6d. to 1s. per day, depending on the locality. There are two crops of corn a season, upon which the former averages about £5 per acre gross. Sugar cane, turned into *piloncillo* or brown sugar, averages from £14 to £19 per acre gross; beans, from £6 to £8 per acre; rice, from £7 to £9 per acre; all other products realising correspondingly

high prices. Thus it will be seen that the profits of the farmer must be large. Hay is not made in any great quantity, but corn fodder is sold to advantage. Near the cities, a lucrative trade is carried on in green barley and corn, which are cut before maturity and delivered in the cities to owners of horses and cows. Cattle breeding is, and always has been, a profitable business in Mexico, consequent upon cheap labour, low taxes, and the large tracts of cheap land which are suitable for grazing only. Until recently, no attempt has been made to improve the stock, but certain large cattle men have now undertaken to do this, and steady improvement is certain henceforth. The demand created during the late war with Spain, and the high prices which obtained in the United States, increased the price of cattle to such an extent that the northern portion of the country has become depopulated of its stock, which, it is said, will take several years to replenish. Dairy farming in the neighbourhood of large cities is lucrative, milk selling at 1s. per gallon, and butter at 1s. 6d. to 2s. per pound. Those engaged in this businese make money rapidly. Fruit and vegetable farming are beginning to attract attention. Formerly this amounted to simply enough for the home market. Now an effort is to be made to supply the United States with early fruit and vegetables. The movement is in its infancy, but it is expected to grow into large proportions. Oranges, lemons, tomatoes, beans, &c., are produced in Mexico from four to eight weeks earlier than in the United States. Hence this is expected to be a profitable business in the near future. Wheat is cultivated in the high table-lands of Central Mexico, and is fairly profitable. It is not the equal of that grown in the United States, either in quantity per acre, or quality. Para and Bermuda grass give pasturage in many sections of the country. They are said to be equal to any in the world. Parts of the country are adapted to the growth of tropical products, viz., coffee, vanilla, rubber, cocoanut, cocoa, &c., the quality of all being excellent. It is said that the best vanilla of the world comes from the State of Vera Cruz, and the best cocoa from the State of Chiapas. The coffee of Michoacan is said to be equal to any; the tobacco of Vera Cruz is preferred by many to that of Havana, and the sugar production of Southern Tamanlipas, or Northern Vera Cruz, is said to be surpassed by that of no country save Hawaii in quantity, and it is more profitable to the producers, for the reason that seven to ten crops are the result of one planting, whereas the Hawaiian planters get only two. Taken as a whole, farming in Mexico is an inviting field for persons of capital and intelligence.

THE LYONS SILK TRADE.

The Chamber of Commerce of Lyons has recently published its report of the silk production of the city for the year 1898. The value of the total product of pure silk stuffs was, in round numbers, £6,140,000, or £240,000 in excess of 1897. The American Consul at Lyons reports that these figures are inferior to those of 1895 and 1896; but they are considered encouraging as marking a resumption of activity. There has been an increase this year in the manufacture of faille, of taffetas, of velvets, of moires, of stuffs for umbrellas, parasols, and muslins. On the other hand, the production of black armures, of all kinds of pongees, of surahs, and similar goods has been less than in 1897. There has been an excess in the manufacture of foulards, stuffs of pure silk, marcelines, and goods used for the furniture of churches, but a decline is observable in the production of linings, serges, lustrine armures, and striped satin pekins. The production of mixed goods in 1898 rose to £4,800,000, an increase of £220,000 over 1895 and a decrease of about the same figure as compared to 1897. A large number of looms were occupied during the year 1898 in making plush for hats and modes, liberty satin, torquoises, cotton-back armures for modes and linings, mixed stuffs for collars and cravats, carriage trimmings and figured and bordered velvet for the Orient and the Indies. Demands from the two latter quarters have been steadily increasing for the last three years, especially for the two species of goods named. Stuffs worked in gold and silver have also found a largely increased demand in the Orient and the East Indies. The output in this line aggregated about £200,000 during the year 1898, and the largest of any year. The manufacture of crepes is reported as assuming largely increased proportions, the production for 1898 being nearly double that of 1895. Crepes de chine increased during the same period from £40,000 to £80,000; the production of muslins increased six-fold; that of grenadines nearly doubled; gilded stuffs used for military uniforms rose from £32,000 to £40,000; and silk, cotton, and woollen passementeries from £40,000 to £60,000.

While Lyons continues to stand at the head of other cities in the production of all fine silks, satins, velvets, and kindred goods, Milan seems to have definitely wrested from her the trade in "thrown" silk. In 1878 the sales of thrown silk—that is to say, of silk yarn—in Milan amounted to 2,475,280 kilograms (5,457,000 lbs.), against 4,244,141 kilograms (9,356,600 lbs.) in Lyons. In 1888 the sales of Milan had risen to 4,538,305 kilograms (10,005,100 lbs.), while Lyons had advanced to only 5,183,520 kilograms (11,427,500 lbs.). Milan continued steadily diminishing the gap until 1898, when she took her place in the lead with a business of 7,549,395 kilograms (16,643,400 lbs.), against 6,462,639 kilogram (14,247,500 lbs.) for Lyons.

Several reasons may be cited for this change of business in the interest of Milan. The Lyons dealers attribute it to the new means of transportation and to the French duty on raw silk. Some years ago, before the balance of this trade began to turn to the side of Milan, the great bulk of the transportation from the Orient was in English and French ships, which made

Marseilles the principal stopping place in the Mediterranean. The German line, which now does much of the business between the Peninsula and the Orient, made Genoa its principal stopping point in the Mediterranean; and as a consequence, the raw silk brought from the Orient goes into Italy and on to Milan, where it is thrown, and by means of the St. Gothard Tunnel forwarded to Switzerland, Germany, and Russia. It is estimated that about 11,000 bales of raw silk are annually landed at Genoa which were formerly put down at Marseilles.—*Board of Trade Journal.*

SAVING LIFE AT SEA.

Information respecting a prize of 100,000 francs that has been founded by the heirs of the late Mr. Anthony Pollok, of Washington, to be awarded during the Paris Exhibition in 1900, to the inventor of the best apparatus for the saving of life at sea, is given in the *Board of Trade Journal.* This prize, which is open to universal competition, is a donation of 100,000 francs. This sum is now on deposit with the American Security and Trust Company of Washington, D.C., and will be paid over to the successful competitor when a decision shall have been rendered by an appointed jury, and formally communicated to the Secretary of State of the United States, through the Commissioner-General of the United States to the International Exhibition of 1900.

The juror selected on behalf of the Government of the United States is Lieutenant William S. Sims, U.S.N., Naval Attaché of the Embassy of the United States at Paris. In considering the award the jury will be governed by the following conditions:—

(1) The total amount of the prize may be awarded to a single individual on condition that the invention is of sufficient practical value and importance to justify the proposed award.

(2) Should several persons enter inventions of equal value, the jury, as it shall consider right and just, may award a portion of the prize to each.

(3) Should none of the inventions entered be of sufficient value to entitle it to the prize, the jury may reject any and all of them, but at the same time shall be empowered to indemnify competing inventors in such amounts as may be deemed advisable. The essential details as to this prize have been agreed upon between Mr. Ferdinand W. Peck, Commissioner-General of the United States to the Paris Exhibition of 1900, and the Honourable Alfred Picard, Commissioner - General of the Universal International Exhibition of 1900. They have also had the substantial assent and approval of the French authorities to the end that the competition for the prize may take place during the exhibition. The instructions to competitors will be issued in due season by the jury, with the sanction and approval of the authorities of the French Exhibition.

THE MANUFACTURE OF SILKWORM GUT IN ITALY.

Some of the inhabitants of the island of Procida manufacture very fine gut from silkworms. They call the product "fili di seta," or "silk threads," their special properties consisting in their strength and flexibility. They are made from the stomachs of silkworms just before they begin to spin their silk, and from their cocoons. Not many worms, in proportion to the gut put on the market, are reared in Procida itself, but the makers buy them from Torre dell' Annunziata, and other neighbouring towns, in great quantities. The following, according to Consul Neville-Rolfe, is the process of manufacture:—The worm is selected when fully matured, that is to say, at the moment when his nourishment ceases, and just before his metamorphosis. He is then cut open, great care being taken not to injure the membrane of the stomach. This is then removed, and the stomachs are then put into a pickle, which is the keynote of the whole process, and the secret of which is carefully kept. When the pickling process is over the workpeople, who are mostly women, take one end of the stomach in their teeth, and draw the other end with their hands. This part of the work requires great dexterity, for the threads are drawn out to a considerable length, the whole value of the product depending, in fact, upon its length in relation to its thickness, and the strain it will carry. There are two seasons for the production, namely, in spring, when the best gut is produced; and in autumn, when the quality is inferior. There is one important market for this specialty, and the whole production is exported to Northern Italy and abroad, at the average price of £3 per pound. The gut is of very small specific gravity, so that a great deal of it goes to a pound-weight. The cost of production is also considersble, as the worms must be bought just at the moment when they are coming into profit for making silk, that is to say, when they are dearest. Again, the results are frequently disappointing, many worms being found, on dissection, not to be suitable, and have to be discarded. The various operations require a good many hands, and though labour is cheap it runs away with a good deal of money, as skilled hands are alone satisfactory. The gut is used for fishing tackle, brushes, and any purpose where fineness and tenacity are jointly requisite.

FOREIGN INDUSTRIAL DESIGNS AT THE PARIS EXHIBITION.

The United States Consul at Berne says that the High Court of Appeal in Paris has recently given an important decision in the case of a Swiss firm, which in its application is far reaching, and affects foreign manufacturers who intend to present to the world in 1900 their best efforts and products. The Swiss manufacturer perceived that certain designs of his,

although registered in France, were extensively copied by a French firm. He brought an action, and a judgment of the High Court of Appeal, to which the case was carried, was entered against him. In announcing the decision, the Court said: "We assume and acknowledge that imitations of registered designs are proved. This case is based on the law promulgated by Imperial decree of 1861, by which foreigners are allowed to register designs in Paris if their country has a reciprocal treaty with France; but the law has fallen into disuse, with a great many others at the epoch of Free Trade agreements. Under international agreement of 1883, foreigners are placed on the same footing as the French, and by virtue of the text of the law of 1806, amended by a decree of 1825, a manufacturer is obliged to deposit his designs, to be protected, with the competent authorities of the district in which his factory is located." "Therefore," says the Consul, "manufacturers who have no factory in France are at the mercy of the French imitators, since under the ruling of the highest court, imitation of designs, &c., is lawfully allowed. Manufacturers registering their designs in Paris, and paying a handsome sum for supposed protection, is in this case a fallacy, although the authorities accept thousands of francs annually for these purposes, based on the Imperial decree of 1861."

THE ARTIFICIAL HATCHING OF SALMON IN NORWAY.

As a result of a visit paid by Herr Landmark to the United States, a new departure has been made in connection with the artificial hatching of salmon in Norway. Formerly the young fry were allowed to escape as soon as they began to require food, and, therefore, when in a very delicate and defenceless condition. They are now retained in captivity, and fed four times a day upon the raw liver of slaughtered animals, until the autumn, after the system which obtains in America. According to Consul Nelson, of Bergen, the results of the first year's experiment at the Government hatchery on the Drammen were satisfactory; on 280,000 ova treated, the loss was only 2 per cent., and in the middle of October about 211,000 fry were turned out, while the per-centage of loss has been still further reduced of late years. A belief is prevalent among the coast fishermen that salmon and sea-trout spawn successfully in salt water, and in this connection a series of experiments were conducted under proper supervision, from which it appeared that (1) roe taken from salmon captured in a river, or from sea-trout which have remained until the spawning time in sea water, cannot be successfully developed in salt water, and (2) salmon and sea-trout roe impregnated in fresh water may be hatched out in brackish water containing a small per-centage of salt up to eight or nine per mille, that is to say, rather less than one-third of the salt contained in the sea water on the Norwegian coast.

PEARL INDUSTRY OF NEW CALEDONIA.

The pearl and oyster industry of New Caledonia is as yet in its infancy. To those who are familiar with these products, which have been supplied for the last half century, and more, from the coral reefs of Torres Straits, Tahiti and Samoan groups, and, later still, from New Guinea, in all of which localities the trade in pearl shell and pearls has obtained the distinction of a regular European market quotation, it may be surprising that the resources of the vast seaboard of New Caledonia and its dependencies have not, ere this, become known and seriously worked. Acting-Consul Erskine is of opinion that the oversight may be accounted for by the fact that the great mineral wealth of the colony has no doubt drawn off the attention of the commercial community; but since the advent of the present governor, great encouragement has been given to the development of the other industrial and commercial resources of the islands, hence large concessions having been granted by the French Government. Syndicates were formed for the working of pearls and pearl shells on the coasts of New Caledonia and the adjacent islands, with the result that at the present moment extensive prospective operations are being carried out to determine the existence and locality of shell banks. There are now two separate parties of concessionaires. The syndicate occupying the whole of the east coast of the island as well as the Chesterfield, Wallis, and Belep groups, is busily engaged in exploring its concessions with the aid of a patent sub-marine apparatus, which is said to be capable of descending to the depth of 100 fathoms, although 40 or 50 fathoms will be all that is required for the present. This machine is carried by a small ketch of about 38 tons, and it appears from the reports received to be working admirably and discovering large banks of shells especially off the north end of the island. Some 12 banks of large extent have been discovered and chartered, one of them, according to information given to Consul Erskine, being about four miles long by about 100 yards wide, at a depth of 25 fathoms. The company working the concessions on the west coast, whose head-quarters are at Paris, is stated to be making valuable finds. From one pound weight of pearls and upwards are said to be exported monthly. Large numbers of these pearls are sometimes found in each shell, which is mostly of a small size and called in New Caledonia the "Pontadine," and apparently of small value for trade purposes. The shell banks found on the north coast of the island lie principally in shallow waters and the oyster is collected by the Loyalty Island boys, who are employed for this purpose by the company at a wage of 30 francs (24s.) a month and rations. It, is however, proposed to import native divers from Tahiti, as they are more experienced at the work than the natives of the Loyalty Islands. Very little export of pearls and shells has so far been made, though parcels of a few tons of shells are occasionally despatched to Europe and fetch from

£40 to £60 per ton. Some of the pearls are valued at from £20 to £120 each. The concessions already mentioned are granted for a period of ten years, with the option of a further extension of ten years to the concessionaires, who must be of French nationality. Consul Erskine says, "If my information can be relied upon it seems likely that the pearl and pearl shell industry of New Caledonia has a very successful future before it, and will no doubt establish a reputation equal to any of the celebrated pearl fisheries in these latitudes."

Correspondence.

ARMOURED GLASS.

The note on this subject, on p. 850 of the *Journal*, would seem to have been written by someone unaware that this glass (called here "wired glass") has been in use for some time in this country, where its valuable qualities are fully appreciated. I enclose one of the British Fire Prevention Committee's reports of a test made last July, the results of which agree with those made in Vienna.

One great advantage from its use in sky-lights is that it will not fall readily if accidentally fractured, and of this I have had satisfactory experience.

Gauge-glasses, or rather guards for them, are not only proposed, but in use.

R. Langton Cole.

23, Throgmorton-street, E.C.
October 26, 1899.

[Mr. Langton Cole's statements seem quite to be borne out by the report he sends of the tests made on sky-lights of wired glass.]

Notes on Books.

Over-pressure. By S. De Brath and F. Beatty. London: G. Philip and Son, 1899.

In this book, the authors have considered very thoroughly both the causes of over-pressure and the means to be taken for the mitigation of this evil. The first three chapters deal with the nervous system, nervous energy, and mental economics, and the titles of the remaining chapters (4 to 8) are "Science Teaching," "History Teaching," "A High Standard," "Without Over-strain," and "the Great Examination Question." The main object of the book, therefore, is to point out how over-strain can be avoided while a high standard is maintained.

The authors point out the importance of moderate hours of brain-work, rising gradually from 4½ hours at eight years old to 7 hours at sixteen years, and under Mental Economics the essentials of method are explained. It is shown that in much teaching the first principles of science are completely misunderstood, and on taking three school text-books on mechanics, geography, and algebra at random, the first principles there stated are said not to be first principles at all from an educator's point of view, but "either (*a*) highly abstract generalisations from an enormous mass of experiment, apart from which they can scarcely be understood; (*b*) inferences from a great body of facts which are remote from, or opposed to, ordinary perceptions, and were only discovered after centuries of research or exploration; or (*c*) conventions which should not be introduced at all till the need for them arises." In place of this the authors affirm that "all knowledge is in minds and not in books, and in minds it passes through two main stages, the inductive and the deductive. These two are halves of one process, and the former precedes the latter in the national growth of science, and should likewise precede it in the individual mind."

In the chapter on "Science Teaching, what and how" the mode of teaching is specially considered, "Herbert Spencer brings out the vital fact that science is nothing else than exact knowledge of the natural forces around us learned by exact methods. It is not distinctively the study of any particular one of them—the knowledge of mechanical forces, nor of molecular affinities, nor of the laws of life, but the mental habit of exactitude working towards ascertainable truth by data open to and verifiable by all." It is the acting upon this view rather than upon the cramming of conclusions and formulæ of the 'ologies, got up for examinations, that the true principles of science-teaching rest.

The proposed remedy for over-pressure is based on the physical laws of health, and stress is laid upon the necessity for adapting the teaching to the powers of the child at each stage of his growth. Also the educational sequence of the subject-matter is to be marked, so that the boy may experience a sense of unity in his instruction.

In the last chapter special attention is given to the great examination question, and the line to be taken in order to remedy the evils of the present system. The evil of regarding all knowledge not as valuable or interesting in itself, but as good to pass an examination with, is censured. An intelligent boy of sixteen once asked: "What is the use of trying to remember all the stuff we have to learn? No one uses Euclid to get his living by—nor Latin or Greek either, unless he is a mere schoolmaster." Thus education is considered solely as a help to success in life, and not as a life-long possession.

THE LIBRARY.

The following books have been presented to the Library since the last announcement:—

Abbott, A., and Arthur Key.—Progressive Lessons in Science. (London: Blackie and Son, 1899.) Presented by the Publishers.

Boulvin, J.—The Entropy Diagram and its Applications. (London: E. & F. N. Spon, 1898.) Presented by the Publishers.

Crosskey, L. R.—Elementary Perspective. (London: Blackie and Son, 1898.) Presented by the Publishers.

DeBrath, S., and F. Beatty. — Over-pressure. (London: C. Philip & Son, 1899.)

Frost, Robert, B.Sc.—Patent Law and Practice. (London: Stevens and Haynes, 1898.) Presented by the Author.

Henderson, J., B.Sc.—Practical Electricity and Magnetism. (London: Longmans, Green and Co.) Presented by the Publishers.

Luff, Arthur S., M.D., B.Sc. — Text-Book of Forensic Medicine and Toxicology. (London: Longmans, Green and Co., two vols., 1895.) Presented by the Author.

Lyon, J. B., C.I.E., F.C.S.—Medical Jurisprudence for India. (Calcutta: Thacker, Spink and Co., 1890.) Presented by the Author.

Mann, J. Dixon, M.D., F.R.C.P.—Forensic Medicine and Toxicology. (London: Charles Griffin and Co., 1898.) Presented by the Author.

Preece, Sir W. H., and Sir James Sivewright.—Telegraphy. (London: Longmans, Green and Co., 1899.) Presented by the Publishers.

Procter, H. R., F.C.S. — Leather Industries. (London: E. and F. N. Spon, 1898.) Presented by the Author.

Shadwell, Arthur, M.A., M.B. — The London Water Supply. (Longmans, Green and Co., 1899.) Presented by the Author.

Slingo, W., and A. Brooker.—Electrical Engineering. (London: Longmans, Green and Co., 1898.) Presented by the Publishers.

Unwin, W. Cawthorne, F.R.S.—The Testing of Materials of Construction. (London: Longmans, Green and Co., 1899.) Presented by the Publishers.

Young, W.—Spons' Architects' and Builders' Price Book. (London: E. and F. N. Spon, 1899.) Presented by the Publishers.

General Notes.

International Statistical Institute.—This Institute held its seventh biennial session at Christiania in September last. The meetings in previous years were held at Rome, Paris, Vienna, Chicago, Berne, and St. Petersburg. The session continued for five days, in two sections, one for demographic and the other for economic subjects.

Cycle Tax in France.—According to a report recently issued by the Department of Indirect Taxation in France the revenue derived from the tax on cycles (*velocipèdes*) amounted in 1898 to £194,344, and the number of machines taxed to 483,414. In 1897 the number assessed to duty was 408,869; in 1896, 329,816; in 1895, 256,084; and in 1894, 203,026.

Proposed Congress at Paris. — An international congress on the numbering or "count" of yarns and threads will be held, under the patronage of the French Government, during the Paris Exhibition of 1900. Among other uses of a settlement is the common basis for estimating tariff duties on most textiles. The organising committee has addressed a circular to French manufacturers to explain the present state of the case. Four international congresses have been held—at Vienna in 1873, at Brussels in 1874, at Turin in 1875, and at Paris in 1876—with a view to the general adoption of the metre and the gramme as bases of universal numbering of textile threads. The resolution proposed received only a partial sanction, and it is hoped that the question may be brought to a successful issue at the Paris Exhibition.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 6...Royal Institution, Albemarle-street, W. 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Sherard Cowper-Coles, "The Electrolytic Treatment of Complex Sulphide Ores."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. Walter F. Reid, "'Velvril' material, a new Substitute for India-rubber and Gutta-percha."

British Architects, 9, Conduit-street, W., 8 p.m. Opening Address by the President, Mr. William Emerson.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. Boyd Dawkins, "The Place of the Welsh in the History of Britain."

Tuesday, Nov. 7...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Opening Address by the President, Sir Douglas Fox, and Reception afterwards by the President.

Colonial, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. John Ferguson, "Ceylon in 1899."

Wednesday, Nov. 8...Geological, Burlington-house, W., 8 p.m. 1. Dr. C. Davison, "The Cornish Earthquakes of March 20th to April 2nd, 1898." 2. Prof. T. T. Groom, "The Geological Structure of Portions of the Malvern and Abberley Hills."

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. President's Opening Address. 2. Discussion on paper by Mr. J. C. Chapman, "Some Aspects of Disconformity and the Judicial Functions of the Patent-office in regard to the same and other Matters."

Thursday, Nov. 9...London Institution, Finsbury-circus, E.C., 6 p.m. Prof. W. M. Flinders Petrie, "Prehistoric Egypt."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Dr. W. Thompson, "Liquid Air."

Friday, Nov. 10...Astronomical, Burlington-house, W., 8 p.m.

Physical, in the Physical Laboratory of the Central Technical College, Exhibition-road, South Kensington, 5 p.m. 1. Mr. F. S. Spiers, "Contact Electricity." 2. Mr. J. B. Tayler, "The Heat o Formation of Alloys."

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FRIDAY, NOVEMBER 10, 1899.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-sixth Session will be held on Wednesday evening, the 15th of November, when an Address by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman of the Council, will be delivered.

Previous to Christmas there will be Five Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 15.—Opening Address of Sir John Wolfe Barry, K.C.B., V.P.Inst.C.E., F.R.S., Chairman of Council.

November 22.—"National Forestry." By D. E. Hutchins, Conservator of Forests, Cape Town. General Michael, C.S.I., will preside.

[In Mr. Hutchins's absence at the Cape, Prof. W. R. Fisher, of Cooper's-hill, has kindly consented to read the paper on his behalf.]

November 29.—"The Great Seals of England." By Allan Wyon. Richard R. Holmes, M.V.C., F.S.A., will preside.

December 6.—"Artificial Silk." By Joseph Cash. Sir Thomas Wardle will preside.

December 13.—"Sea Angling and Legislation." By F. G. Aflalo.

December 20.—"Bi-Manual Training by Blackboard Drawing." By H. Bloomfield Bare, F.R.I.B.A.

Papers for meetings after Christmas:—

"Electric Traction." Charles H. Gadsby.

"Steam Motors for Common Roads." By John I. Thornycroft.

"The Diffraction Process of Colour Photography." By Professor R. W. Wood.

"Coal in South-Eastern England." By Professor W. Boyd Dawkins, M.A., F.R.S.

"A National Repository of Science and Art." By Professor W. M. Flinders Petrie, D.C.L.

"The Electrical Induction Motor on Mountain Railways." By Professor Charles A. Carus-Wilson, M.A.

"Ventilation without Draughts." By Arthur Rigg.

"The Undeveloped Resources of the Bolivian Andes." By Sir Martin Conway.

"The Orloff Process of Colour Printing." By W. H. Ward.

"Continuation School Work in Rural Districts." By H. Macan.

Indian Section.

The meetings of this Section will take place on the following Thursday afternoons at 4.30.

December 14, January 18, February 8, April 26, May 17.

December 14.—"Round about the Andamans and Nicobars." By Colonel R. C. Temple, C.I.E.

"India in the 19th Century." By Sir William Lee-Warner, K.C.S.I., M.A.

"The Industrial Development of India." By J. A. Baines, C.S.I.

"New Projects of Railway Communication with India." By J. M. Maclean, M.P.

"Indian and English Criminal Procedure." By Sir John Scott, K.C.M.G., D.C.L.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday afternoons, at 4.30 and the first meeting on Thursday:—

November 23 (Thursday), January 23, February 27, March 20.

November 23.—"Old and New Colombo." By John Ferguson. Sir Thomas Sutherland, G.C.M.G., LL.D., M.P., will preside.

"The Colonies in the 19th Century." By The Right Hon. Sir Charles Dilke, Bart., M.P.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday evenings at 8 o'clock:—

January 30, February 13, March 13, April 3, May 8, 29.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday evenings at 8 o'clock:—

Henry Hardinge Cunynghame, "Art Enamelling upon Metals." Four Lectures.

Lecture I.—November 20.

What enamel is—Various styles of enamelling—Cloissoné—Champlevé—Mediæval art—The Renaissance—Limoges enamels—Choice of a style in enamelling.

LECTURE II.—NOVEMBER 27.

Method of executing Limoges enamels—Preparation of the metal plate, of the enamels—The firing paillons.

LECTURE III.—DECEMBER 4.

The method of making enamels—Fluxes—The metallic oxides.

LECTURE IV.—DECEMBER 11.

The application of enamel to jewellery—Gold working—Gilding.

BENNETT H. BROUGH, "Metalliferous Deposits." Four Lectures.

January 22, 29, February, 5, 12.

E. SANGER SHEPHERD, "Photography of Colour." Four Lectures.

March 5, 12, 19, 26.

MAJOR PHILIP CARDEW, R.E., "The Control, Regulation, and Measurement of the Supply of Electrical Energy." Three Lectures.

May 7, 14, 21.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday Evenings, January 3 and 10, at Seven o'clock, by HERBERT JACKSON, on "The Phenomena of Phosphorescence."

Miscellaneous.

ELECTRIC TRACTION IN CHICAGO.

In view of the approaching convention of the American Street Railway Association, which takes place this year in Chicago, the American papers have published articles containing a survey of the electric traction systems in that city. There are no less than nine companies operating street railways in Chicago, and the track mileage amounts to 844 miles. There are 1,919 motor cars and 987 trailers. Besides these there are four elevated railways, which have altogether 70 miles of track, 146 motor-cars, and 418 passenger cars.

The city contains examples of all kinds of practice, from fairly ancient down to the most recent. Of the latter the South Side Elevated Railway may be taken as an example, this railway having 18·62 miles of track, 46 motor cars, and 180 passenger cars. Its present power-house equipment consists of four 800-kilowatt 12-pole Westinghouse compound-wound machines with a large overload capacity. The field pieces are vertically split, and slide at right angles to the shaft, thus giving access to the armatures, which are mounted directly on the engine shaft. Each is directly connected to a horizontal cross-compound Allis engine, rated at 1,200 horse-power. The generators are guaranteed to operate continuously at 1,835 amperes, the voltage being 650. Two additional units of double the size are being put in. The boilers, 12 in number, are of the Babcock-Willcox type, fitted with mechanical stokers, and there is a complete system of coal-handling apparatus. Not being situated favourably with regard to condensing water, a Wheeler cooling tower is employed, 34 feet high, 16½ feet wide, and 64 feet long. It contains vertical wire screens, down which the water flows. Ten fans, 10 feet in diameter, operate in pairs from the same shaft, forcing air into the tower. Two large storage batteries, situated on the line, each three miles from the generating station, provide for the fluctuations in the load. Each consists of 263 cells, and has a capacity of 750 kilowatts, delivering 2,400 amperes to the line, and at times 4,300 amperes have been taken from one battery. The only attendance on the battery is that given by the ticket agent at one station and the train despatcher at the other, who have merely to attend to the circuit breakers. The cars, which are operated on the Sprague multiple unit system, require 2 kilowatt hours per car mile in summer, and 3·35 in winter, these figures including lighting, heating, station lighting, and all auxiliary motors. During the first six months of the present year the company claims to have produced electrical energy at an average of ·427 cent. per kilowatt-hour.

The Calumet Street Railway is chiefly interesting through the illustration it affords of the progress in the equipment of power houses. There are four 150-kilowatt railway generators belted to Ball cross-compound engines which have been transformed from non-condensing to condensing; also a 500-horse-power Buckeye engine directly connected to a 50-kilowatt G.E. generator. The Walker generators were substituted for the original Detroit generators, and one is at times operated as a booster to raise the voltage to 900 or 1,000 volts if required. When condensing was introduced, two Deane condensers were put in and a system of cooling tables installed. By this means a vacuum of 22 inches or 23 inches is secured when the temperature of the atmosphere is 90° and the cooling tank 120°. The tables are 12 feet wide and 70 feet long, the water passing from the delivery pipe to one extremity of the first table, flowing to the other end in a thin sheet, thence falling upon a second table, from which it finally flows into a pond and is pumped to the condensers.

The largest power station in Chicago is that of the Chicago Union Traction Co., recently formed by the consolidation of two other companies, and operating 249 miles of track and 607 motor cars. It contains six engines—four of 2,000, one of 1,700, and one of 1,000 horse-power. They are of three different makes, but all cross-compound and directly connected to their generators. The dynamos first put

in had commutators on the periphery of the armature, but the majority of these have been altered and the usual shaft commutators substituted. The Chicago City Railway Co., operating 157 miles of track, 776 motor cars, and 749 trailers, has three stations, with an aggregate capacity of 10,700 kilowatts, all the dynamos being rope-driven and all the engines non-condensing.—*Electrician.*

USES OF TOBACCO JUICE IN FRANCE.

All tobacco shops in France are compelled to keep a stock of what is called "tobacco juice, rich in nicotine and guaranteed." This is manufactured by the tobacco monopoly in Paris. The article, it is claimed, possesses the following advantages:—(1) It is free from all matter susceptible of fermentation, and keeps for an indefinite period if in closed vessels. (2) It contains no resinous matter, and is almost transparent, therefore, it does not injure or clog the spraying machines, and does not stain plants or flowers or the wool of sheep. (3) It has a Government guarantee as to the proportion of nicotine it contains, which never varies. This product, it is also claimed, contains from five to six times the quantity of nicotine that may be found in ordinary tobacco juice, and that, therefore, one-fifth to one-sixth of the quantity will accomplish the object to which it is applied. For spraying purposes the product is employed in the proportion of one part of juice to one-hundred parts of water. It is stated that the spraying of plants should be done after sunset, and that they should be sprinkled with clean water on the following day. For fumigating hot-houses the proportion is one part of juice to five of water. The mixture is sprayed upon bricks or iron sheets heated to a temperature sufficiently high to produce rapid evaporation. It is claimed that insects and parasites are absolutely destroyed by this process. It is said, furthermore, that the proportion is most efficacious for the destruction of all insects in cattle, as well as being a preventative of all manner of parasite attacks. For these purposes the juice is mixed in the proportion of one part to twenty of water. It is recommended that the lotion be not used as a general bath, but applied gradually on limited surfaces. It should not be brought in contact with sores or erosions of any kind. The benefits accruing from the use of these mixtures are said to be greatly enhanced by mixing 100 grammes (about $3\frac{1}{2}$ ounces) of soda crystals with each litre (1·7 pints) of diluted juice. Regarding the use of this product in the Alpes Maritimes, the United States Consul at Nice says that it is rapidly coming into general favour for all the purposes mentioned above. He has seen it used with complete success in curing what is popularly called "le noir." This parasitic affliction is not confined to orange, lemon, olive, and other trees, but has been most disastrous to such vegetables as potatoes, beans, peas, tomatoes, &c. He has also seen whole rows of orange trees so thickly coated with parasites that every leaf appeared coated with soot (hence the popular appellation, "le noir,") and he has been enabled to verify the fact that three or four applications of the lotion have prevented the disease from attacking new leaves, and have caused the disappearance of the black deposit upon those attacked. A proprietor of an olive grove in Nice has recently stated that the use of the juice in combating "le noir," which has destroyed many thousands of olive trees in the department, is most costly, but at the same time very efficacious. The spraying machines used to spread the mixture are the same as those employed in applying sulphate of copper to vineyards. Efforts have been made to ascertain whether the use of tobacco juice would not be more desirable in treating vines for the cure of the oidium—a parasitic disease of the vine leaves—than sulphate of copper, but it appears impossible to discover anyone who has experimented with the two treatments. It would appear, at first sight, that tobacco juice would be preferable, as sulphate has always been considered a preventive of attacks upon the grapes themselves, especially after the bunches are completely developed, whereas the oidium attacks only the bases and indirectly the vitality of the plant.

IRON AND STEEL WORKS OF JAPAN.

The iron and steel plant which the Government of Japan is now building is situated at Kiushiu, about ten miles from Moji, near Wakamatsu. The works face a bay called Dokai. It is intended to dredge out this bay, so that there will be a fair way to the wharf now building at the works, by which vessels of about 3,000 tons burden may reach the wharves and discharge iron ore. The ore will have to be brought either from the Yangtsze, in China, or from the Kamaishi mines, in the north of Japan. There is an abundance of coal within a radius of 100 miles from the works. The ore will be carried from the wharf by electric cranes to the rear of the works, where the ore bins are placed. These bins are designed to hold ore enough to keep two blast furnaces going for two months. The blast furnaces will have a capacity of 350 tons of ore each in 24 hours, and each is calculated to produce 165 tons of pig iron in this time. The blast and roasting furnaces are well supplied with electric hoists. In fact, all over the works as many labour-saving appliances as possible have been adopted. The system is American, though the plant has all to be made in Germany. The molten metal from the furnaces will generally be transferred direct to the mixers, which are of 160 tons capacity. The total annual capacity of the works is 90,000 tons—that is, 45,000 tons each of Bessemer and open-hearth steel, for which 120,000 tons of pig iron will be

required. It is proposed to roll rails of all sections and sizes, plates up to 2 inches thick and 7 feet wide, rounds, squares, and angles of all sizes, and joists up to 12 inches high. With the exception of that for the locomotives the steam generated for driving all of the machinery will be heated by the waste gases from the different furnaces.—*Feilden's Magazine.*

TEXTILE PLANTS OF RUSSIA.

It is a well-established fact that Russia has for several years past furnished nearly four-fifths of the flaxen tow consumed by all countries. The growth of flax covers a large territory, which is worked by peasants, and as a rule the product is of inferior quality. Its export, however, is a source of great wealth, and has been one of the principal factors in the industrial development of Russia. As a greater extent of land is covered by flax than by any other product, Russia is in the foremost rank as a flax producer. Owing to the fact that flax thrives under severe climatic conditions, it was planted extensively in Russia at a time when this country had very little trade with European countries. The United States Commercial Agent at Roubaix says that in the western districts and Baltic provinces the Upper Volga in Joroslav, Kostroma, and near Lake Lodoga, flax is grown with a view to the production of tow. In 1886 an area of over 1,000,000 hectares (2,471,000 acres) was covered with flax, and the yield was 275,000,000 kilogrammes (606,265,000 lbs.) of flaxen tow against 225,000,000 kilogrammes (496,035,000 lbs.) produced by all countries combined. In 1897 more than 2,300,000 hectares (5,683,000 acres) were cultivated, and the yield was 562,585,000 kilogrammes (1,238,000,000 lbs.) The exportation in 1897, which was almost entirely through Europe, amounted in value to £8,000,000, and it was this superabundance of Russian flax which arrested the production in Belgium, where it had been grown under the most favourable conditions, and with large profit. Germany is the natural outlet of the Russian commercial current; she imported more than £1,300,000 worth of Russian flax in 1897, and exported about £540,000 worth. Hemp covers a smaller area than flax in European Russia; this is due to the climate. The principal plantations are in Koursk, Toula, Kalouga, Riazan, and in the western districts Kovno, Vilna, Smolensk, and Mohilew. During the past few years the surface cultivated has not increased very rapidly, but it is worthy of note that while the culture of hemp is almost stationary in all Europe, the Russians have stepped to the front. Central Siberia, connected by rail with the centres of textile industry in European Russia, is a large producer of hemp. In 1897 Russia sold more than 5,000,000 hectolitres (13,700,000 bushels) of seed and 200,000,000 hectolitres (550,000,000 bushels) in round numbers of tow, of which 98,000,000 hectolitres (269,000,000 bushels) came from Siberia. The total exportation from Russia to Germany was quite equal to that of flax, and the total sales amounted to £1,370,000. Russia is about to become a large producer of raw cotton. The Trans Caucasian country has cotton lands in the valley of Koura, near Elizabethpol, in the high plain of Erivan, as well as in other localities, and judicious irrigation will extend these fields. Russian Turkestan is, however, destined to become the greatest cotton-producing district, and will, it is said, shortly be a rival to Egypt. The Commercial Society of Central Asia, through the aid of the Minister for the Colonies, has introduced "upland" cotton into Ferghana, Samarcand, and the oases of Syr Daria and Amou Daria. It is planted by the side of native cotton of inferior quality, and each year marks an advance in the surface sown, as well as yield. Irrigation will reclaim from the steppes of Turkestan several hundred thousand acres for agricultural purposes. The greatest drawback is the climate, which is exceedingly dry in summer, while the autumn is marked by early frosts. In 1890, Russian Turkestan had 60,000 hectares (148,000 acres) planted with "upland" cotton, of which 35,000 hectares (86,000 acres) were in Ferghana. This land yielded 14,880,000 kilogrammes (32,736,000 lbs.) of cotton. There were planted with native cotton 31,960 hectares (78,941 acres), which yielded 5,500,000 kilogrammes (12,100,000 lbs.). In 1893, 175,000 hectares (432,000 acres) were planted with "upland," and 25,000 hectares (61,000 acres) with native cotton. In 1895, the production amounted to 80,000,000 kilogrammes (176,000,000 lbs.) of "upland," and 9,335,000 kilogrammes (20,537,000 lbs.) of native cotton. Russian Turkestan should produce more than 120,000,000 kilogrammes (264,000,000 lbs.) of textile growth. To this may be added the production of Bokhara and Khiva, which are under the control of Russia, and which export more than 40,000,000 kilogrammes (88,000,000 lbs.) of cotton. Through the Trans-Siberian road Russia will inevitably drain the basin of tho Yang-tze-kiang in China of a part of its harvest of 290,000,000 kilogrammes (638,000,000 lbs.), until the textile industry of the Chinese is better organised than at present. Without counting the contribution from the latter source, Russian mills consumed more than 150,000,000 kilogrammes (330,000,000 lbs.) of raw material in 1897. Russia can already do without Egypt, India, and the United States. In Trans-Caucasia and in Turkestan (Khokand) Russia grows silk also, and in 1897 exported £37,500 worth of cocoons. She will buy largely, however, for many years to come from Italy, China, and Persia, as well as through Germany. In 1897 she bought £1,311,000 worth of raw silk. The extension of the Trans-Caspian railroad from Samarcand to Khokand and the completion of the Trans-Siberian road will, however, change these conditions.

General Notes.

Flax Culture in England.—It appears from a recent return that the acreage under flax cultivation in this country has fallen off from 895 acres in 1898 to 465 acres in 1899. Lincolnshire has dropped from 109 to 20 acres, Norfolk from 10 to 5 acres. The area in the East Riding, the largest flax growing county, is reduced from 258 acres in 1898 to 106 acres in 1899.

Electric Tramways.—Electric tramways, or street railroads, as they are called in the United States, now produce nearly as large an income as the steam railroads. The *Electrical Engineer* states that the total invested capital in the street railway systems of the United States is estimated at £350,000,000. The annual income is estimated at £35,000,000, while the annual income of the steam railroads is estimated at £54,000,000. The electric street railroads carry 5,000 million passengers annually, or ten times as many as the steam railroads.

Compressed Air for Street Traction.—Ten cars driven by compressed air are now running in New York, and the experience derived from actual operation is reported to be satisfactory. The cars run smoothly, and, with the exception of a slight sound from the exhaust, there is practically no noise. It is pointed out that, with everything equal in the matter of operating the system, there should be a decided advantage in the economy of the air cars, for the reason that there is no expense corresponding to such items as the maintenance of overhead or underground trolley, the cost of switchboards, and the burning out of motors.

Imports of Clocks and Watches.—The value of clocks and parts thereof imported into this country during the month of August last was £47,521, as compared with £39,732 in August of 1898, and £37,059 in the same month of 1897. The clocks and parts thereof from France were valued at £10,832; from the United States, £6,594; and from other countries, £30,095. The total value of the clocks imported during the eight months ending August was £360,229. The value of watches and parts thereof imported during August last was £142,117, as compared with £109,678 in the same month of 1898, and £84,874 in the same period of 1897. The total value for the eight months ending August, 1899, was £1,004,989, as compared with £779,890 for the same period of 1898, and £775,169 for the same period of 1897.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 13...Surveyors, 12, Great George-street, S.W. 8 p.m. Opening Address by the President, Mr. T. M. Rickman.

Geographical, University of London, Burlington-gardens, W., 3½ p.m. 1. Introductory Address by the President. 2. Mr. W. R. Rickmers, "Travels in Bokhara."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. B. Wheatley, "The Tower of London: Fortress, Palace, and Prison."

Tuesday, Nov. 14...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. H. H. Dalrymple-Hay, "The Waterloo and City Railway." 2. Mr. B. M. Jenkin, "The Electrical Equipment of the Waterloo and City Railway."

Wednesday, Nov. 15...SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. Opening Meeting of the 146th Session. Chairman's Address.

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. Richard H. Curtis, "The Diurnal Variation of the Barometer in the British Isles." 2. Mr. G. J. Symons, "Note on Earth Temperature Observations."

Microscopical, 20, Hanover-square, W., 7½ p.m. Exhibition of *Foraminifera*, by Mr. A. Earland.

Entomological, 11, Chandos-street, W., 7 p.m.

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Mr. J. A. Richard, "The Cripple Creek Goldfields." 2. Mr. H. H. Greenway, "Notes on the Cyanide Process."

Manchester Geographical Society, Memorial-hall, Albert square, 7½ p.m. Colonel Mellor, M.P., "Egypt and Her Monuments."

Thursday, Nov. 16...Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. C. Worsdell, "The Comparative Anatomy of certain Species of Encephalartos, a genus of the Cycadaceæ." 2. Mr. W. T. Calman, "A Collection of Brachyura from Torres Straits."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. W. J. Sell and F. W. Dootson, "The Chlorine Derivatives of Pyridine;" (Part IV.) "Constitution of the Tetrachloropyridines." 2. Messrs. Wyndham R. Dunstan and H. M. Read, "Contributions to our knowledge of the Aconite Alkaloids;" (Part IV.) "Japaconite and the Alkaloids of Japanese Aconite." 3. Dr. H. M. Dawson and Mr. P. Williams, "The Determination of Transition Temperatures."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. G. Langley, "Music in its relation to Painting and Poetry."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Opening Address by the President, Prof. Silvanus P. Thompson.

Historical, St. Martin's Town-hall, Charing-cross-road, 5 p.m.

Imperial Institute, South Kensington, 8½ p.m Mr. B. Worsfield, "England in South Africa." (Lecture II.). "The Dismemberment of European South Africa."

Friday, Nov. 17...North-East Coast Institute of Engineers and Shipbuilders, Newcastle-upon-Tyne, 7½ p.m. Mr. B. G. Nichol, "Worm Gearing."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and Periodicals.

TRANSACTIONS, &C.

American Academy of Arts and Sciences, Proceedings.
American Academy of Political and Social Science, Annals.
American Chemical Society, Journal.
American Institute of Electrical Engineers, Transactions.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions and Proceedings.
Architectural Association, Notes.
Association of Engineering Societies (American), Journal.
Australasian Association for the Advancement of Science, Report.
Australasian Institution of Mining Engineers, Transactions.
Bath and West and Southern Counties Society, Journal.
British Association for the Advancement of Science, Report.
British Guiana, Royal Agricultural and Commercial Society, Journal.
British Horological Institute, Horological Journal.
Camera Club, Journal.
Canada, Royal Society, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Society of Civil Engineers, Transactions.
Chemical Society, Journal.
Cleveland Institution of Engineers, Proceedings.
Cobden Club, Publications.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, Bulletin de la Classe d'Industrie et de Commerce.
Geological Society, Quarterly Journal.
Glasgow Philosophical Society, Proceedings.
Imperial Institute, Journal.
Incorporated Gas Institute, Transactions.
India, Geological Survey of, Memoirs, Records and Palæontologia Indica.
——, Government of, Agricultural Ledger.
Indian Meteorological Department, Report.
Institute of Bankers, Journal.
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Institution of Engineers and Shipbuilders in Scotland, Transactions.
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Institution of Mining and Metallurgy, Transactions.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Jamaica, Institute of, Journal.
Japan, College of Science, Imperial University, Journal.
Japan Society, Transactions and Proceedings.
Kew Gardens Bulletin.
Linnæan Society, Journal.
London Chamber of Commerce, Journal.
Lyon, Société d'Agriculture, Sciences et Industrie, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
Massachusetts Institute of Technology. Technology Quarterly and Proceedings of the Society of Arts.
Munich, Polytechnischer - Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Association for the Promotion of Technical and Secondary Education. Record.
National Indian Association, "The Indian Magazine and Review."
Nederlandsche Maatschappij ter Bevordering van Nijverheid, Tijdschrift.
New South Wales, Royal Society, Journal and Proceedings.
New York Academy of Sciences, Annals and Transactions.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Nova Scotian Institute of Science, Transactions.
Paris, Conservatoire National des Arts et Metiers, Annales.
——, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Geographie Commerciale, Bulletin.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Revue.
Patent Agents, Chartered Institute of, Transactions.
Patent-office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Pharmaceutical Society, "The Pharmaceutical Journal."

Philadelphia, Academy of Natural Sciences, Proceedings.
———, Engineers' Club Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Geographical Society, "The Geographical Journal."
Royal Institute of British Architects, Journal.
Royal Institution of Cornwall, Journal.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Photographic Society of Great Britain, "The Photographic Journal."
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Sanitary Institute, Journal.
Smithsonian Institution, Report and Publications.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers aud Colourists, Journal.
Society of Engineers, Transactions.
Society of Public Analysts, "The Analyst."
South Wales Institute of Engineers, Proceedings.
Victoria Institute, Journal of the Transactions.
Wisconsin Academy of Sciences, Arts, and Letters, Transactions.

PERIODICALS.

Weekly.

Amateur Photographer.
American Architect and Building News.
American Gas Light Journal.
American Manufacturer and Iron World.
Architect.
Architecture and Building (New York).
Athenæum.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
Capitalist.
Chemical News.
Chemist and Druggist.
Chronique Industrielle.
Colliery Guardian.
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Cosmos: Revue des Sciences.
Eclairage Electrique.
Electrical Engineer.
Electrical Review.
Electrician.
Electricien (Paris).
Electricity.
Engineer.
Engineering.
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Engineering Record (New York).
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Gardeners' Chronicle.
Gardening World.
Herapath's Railway Journal.
Indian and Eastern Engineer.
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Invention.
Iron and Coal Trades Review.
Ironmonger.
Journal of Acetylene Gas Lighting.
Journal of Gas Lighting.
Journal d'Hygiène.
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Mechanical Engineer.
Medical Press and Circular.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Nature.
Photographic News.
Photography.
Practical Engineer.
Produce Markets' Review.
Public Health Engineer.
Publishers' Circular.
Queen.
Revue Industrielle.
Sanitary Record.
School Board Chronicle.
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Scientific American.
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Textile Mercury.
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Fortnightly.

Brewers' Guardian.
Corps Gras Industriels.
Country Brewers' Gazette.
Finance Chronicle.
Irish Builder.
Jeweller and Metalworker.
Moniteur des Produits Chimiques.
Perak Government Gazette.
Science and Art of Mining.

Monthly.

Arms and Explosives.
Automotor.
Bookseller.
Brewers' Journal.
British Indian Commerce.
British Trade Journal.
Building Societies' Gazette.
Cabinet Maker and Art Furnisher.
Canadian Patent Office Record.
Caterer and Refreshment Contractors' Gazette
Coach Builders' and Wheelwrights' Art Journal.
Dyer and Calico Printer.
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Engineering Magazine (New York).
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Essex Review.
Giornale del Genio Civile (Rome).
Hardware Trade Journal.
Inland Architect (Chicago).
Inventors' Review.
Irish Textile Journal.
Labour Co-partnership.
Leather Trades' Circular.
Machinery.
Machinery Market.
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Mariner.
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Mois Scientifique et Industriel.
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Music.
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Oils, Colours, and Drysalteries.
Paper Makers' Monthly Journal.
Philosophical Magazine.
Piano, Organ, and Music Trades Journal.
Plumber and Decorator.
Polytechnisches Centralblatt (Berlin).
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Propriété Industrielle.
Railway Engineer.
Saddlers, Harness Makers, and Carriage Builders Gazette.
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Symons's Monthly Meteorological Magazine.
Textile Manufacturer.
Textile Recorder.
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Watchmaker, Jeweller, and Silversmith.

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Ceylon Observer (Overland Edition).
Daily Inter Ocean (Chicago).
Home and Colonial Mail.
London Commercial Record.
London and China Telegraph.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
Shipping Gazette and Lloyd's List (Weekly Summary).
Times of Ceylon (Weekly Summary).
Times of India (Overland Weekly Edition).

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